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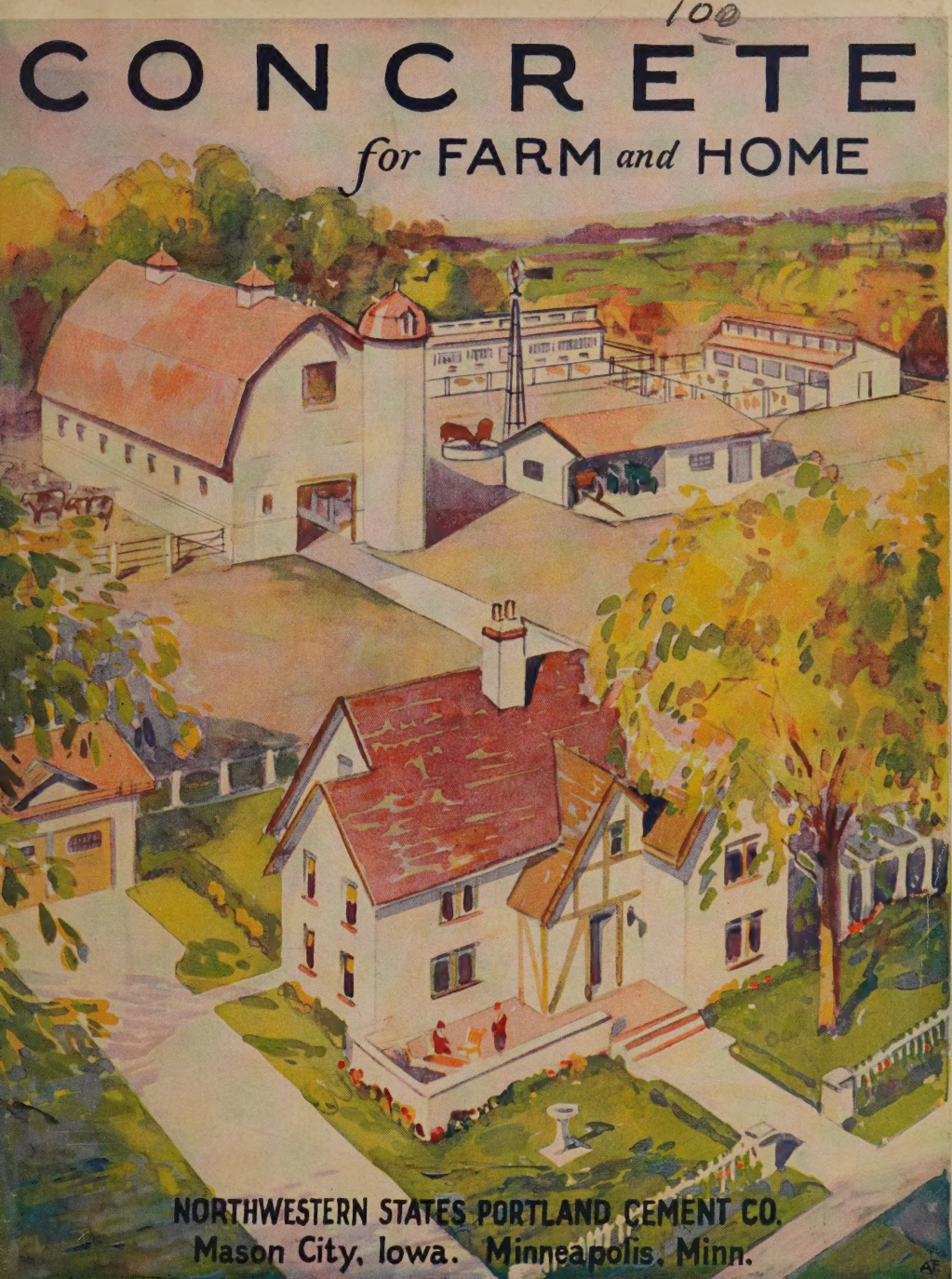
CONCRETE

for FARM *and* HOME



NORTHWESTERN STATES PORTLAND CEMENT CO.
Mason City, Iowa. Minneapolis, Minn.

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CONCRETE FOR FARM AND HOME

A Manual on Farm Concrete

CONCRETE is used in countless ways by the American farmer. Whenever he wants to build sanitary, durable, easy-to-clean floors in his barns, poultry houses, granaries or other farm structures, concrete is his choice. For basement walls, foundations, fruit and vegetable storage cellars, storm shelters, septic tanks and all other farm construction built partly or entirely underground, concrete is used because it does not rot nor rust when in contact with the soil. With concrete walls and floors, rats and mice are built out of corn cribs, grain bins and other places where feeds are kept; no rodent can gnaw through concrete.

Employed in the construction of the farm house, concrete gives the same fire protection as when used to make fireproof large hotels and school buildings. Where great loads are to be supported concrete serves admirably. Huge skyscrapers rest on concrete foundations.

Along with all the other advantages concrete is decidedly economical. Sand and pebbles which make up the bulk of the mixture can usually be obtained locally at low cost. First cost is the last cost because of the great durability of concrete.

Making concrete is interesting, fascinating work and the ability to turn out first class concrete is readily acquired even by the beginner if care is taken to observe the simple rules given in this publication.

From data prepared by the PORTLAND CEMENT ASSOCIATION

Northwestern States Portland Cement Co.

MASON CITY, IOWA

MINNEAPOLIS, MINN. OMAHA, NEBR.

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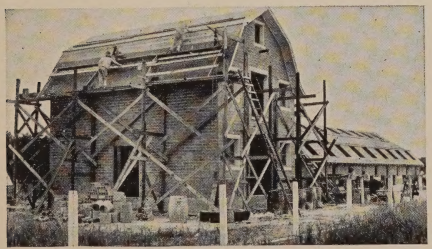
CHAPTER I

FUNDAMENTALS OF GOOD CONCRETE

PRACTICALLY all building material dealers handle portland cement. It is packed and shipped in cloth sacks or paper bags, or occasionally in bulk. For convenience in measuring, 1 cubic foot of cement (94 pounds) is placed in each sack. While the purchaser pays for cloth sacks along with the cement, the sacks are returnable when empty if they are in good condition, and the dealer will buy them back. Sacks that have been wet, torn or otherwise rendered unfit for further use are not redeemable. Paper bags are not returnable. Care should be taken that cement is kept in a dry place until used.

Northwestern States Portland Cement is tested repeatedly and will produce good concrete when properly combined with the other materials necessary for a concrete mixture.

What Concrete Is Concrete is a mixture of cement, water, and inert materials (usually sand and pebbles or crushed rock or crushed slag) which, when placed in forms in a plastic condition, becomes hard like stone because of a process known as the hydration of the cement. When cement is properly cured, hardening continues for a long time after the concrete has acquired sufficient strength for the work intended. This continual increase in strength is the quality by which concrete differs from all other materials. Concrete grows stronger instead of weakening with age.



Well-built, well planned farm structures are essential in profitable farm operation.

Simple tools for making and placing concrete: Water barrel and pail, steel pan wheelbarrow for handling dry aggregate and concrete mixture to forms; screen for separating sand from pebbles; square pointed shovel for turning and mixing concrete, and wooden float for finishing.

The correct proportions of water, cement, sand and pebbles to use in the mixture is governed by the character of the work for which the concrete is intended. Until the discovery of the law that there is a direct relation between the strength of concrete and the amount of water used per sack of cement, it was customary to specify mixtures as one part cement to a certain number of parts of sand and pebbles or crushed rock. In modern practice the quantity of mixing water is specified according to the class of work for which concrete is to be used.

In a concrete mixture, cement and water form a paste which, upon hardening, acts as a binder cementing the particles of sand and pebbles together into a permanent mass. The use of too much mixing water thins or dilutes the paste, weakening its cementing properties. Consequently it is important that the proper proportions of cement and water be used for best

TABLE I

RECOMMENDED MIXTURES FOR SEVERAL CLASSES OF CONSTRUCTION

Intended primarily for use on small jobs

Kind of Work	Gallons of Water to Add to Each One Sack Batch			Trial Mixture For First Batch			Maximum Aggregate Size
	Dry Sand and Pebbles	Moist Sand and Pebbles	Wet Sand and Pebbles	Cement	Sand	Pebbles	
				Sacks	Cu.ft.	Cu.ft.	Ins.
Foundation walls which need not be watertight, mass concrete for footings, retaining walls, engine bases, etc.	7½	6	5	1	3	5	2
Watertight basement walls and pits, walls above grounds, grain bins, silos, manure pits, scale pits, dipping vats, dams, lawn rollers, hot beds, cold frames, storage cellar walls, etc.	6½	5	4½	1	2½	3½	1½
Water storage tanks, cisterns, septic tanks, water-tight floors, sidewalks, feeding floors, barnyard pavements, driveways, barn approaches, porch floors, basement floors, steps, corner posts, gate posts, piers, columns, sills, lintels, chimney caps, etc.	5½	4½	3¾	1	2	3	1
Fence posts, flower boxes, garden furniture and other work of very thin sections.	4½	3¾	3½	1	2	2	¾

The use of this table can best be explained by example. Suppose it is desired to determine proper proportions for building a septic tank.

With dry sand and pebbles the recommended quantity of water is 5½ gallons for a one-sack batch. If sand and pebbles are in a damp condition only 4¼ gallons should be added. If aggregates are dripping wet only 3¾ gallons of additional water are required.

The trial mixture for this class of work is given as 1 part cement to 2 parts sand and 3 parts pebbles (1:2:3). It may be necessary to change the amounts of sand and pebbles as discussed on page 5 to produce a smooth, plastic, workable mixture. Under no circumstance change the ratio of water to cement from the amounts given.

Determining Proportions of Sand and Pebbles

In Table I trial proportions of cement to sand and pebbles are suggested. It may be found that these give too stiff a mix, too wet a mix or a mix that lacks smoothness and workability. This can and should be corrected by changing slightly the proportions of sand and pebbles.

For example, suppose the addition of the recommended quantity of water with the trial proportions suggested (See Table I) gives a mixture that is too wet. Add sand and pebbles slowly until the right degree of wetness is obtained.

On the other hand, if the mixture is too stiff with the suggested proportions, use less aggregates in the next batch. In this way the exact proportions for a given job can be obtained.

The following recommendations (Table II) will prove helpful in arriving at best proportions of sand to pebbles. All measurements are based on moist sand. If sand is absolutely dry, a condition seldom encountered, use 25 per cent less.

results, the exact proportions depending upon the work.

Table I gives recommended quantities of water to add to each one sack batch of concrete for all the classes of farm structures usually built. It also suggests proportions of cement to sand and pebbles to use in trial batches.

Note that with dry sand and pebbles more water is added than when these materials are in a damp condition. This is true since the moisture present in damp aggregates is free to act on the cement.

Old buildings can be given a new lease of life by constructing permanent concrete foundation walls under them.

TABLE II

For coarse aggregate ranging from ¼ inch up to ½ inch, use approximately equal parts sand and pebbles.

For coarse aggregate ranging from ¼ inch up to ¾ inch, use about ¾ as much sand as pebbles.

For coarse aggregate ranging from ¼ inch up to 1½ inches, use about half as much sand as pebbles.

What is a Workable Mixture A workable mixture is one of such plasticity and degree of wetness that it can be placed in the forms readily, and that with spading or tamping will result in a dense concrete. In a workable mixture there is sufficient cement-sand mortar to give good smooth surfaces free from rough spots, called honeycombing, and to bind the pieces of coarse aggregate into the mass so they will not separate out in handling.

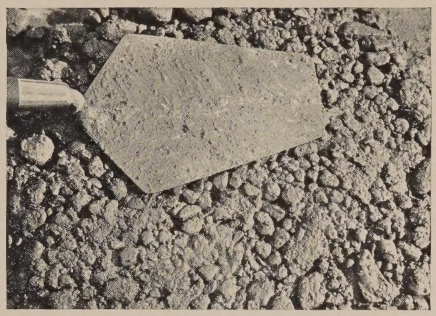
In other words there should be just enough cement-sand mortar to fill completely the spaces between the pebbles and to insure a smooth plastic mix. Mixtures with a deficiency of mortar will be harsh, hard to work and difficult to finish. On the other hand oversanding or the use of too much sand should be guarded against as it increases porosity, and reduces the amount of concrete that can be produced with a sack of cement.

A workable mixture for one class of construction may be too stiff for another—that is, concrete to be deposited in thin sections must be more plastic than if used in heavier work. Very wet, sloppy mixtures are to be avoided at all times as they segregate badly and result in weak, porous concrete.

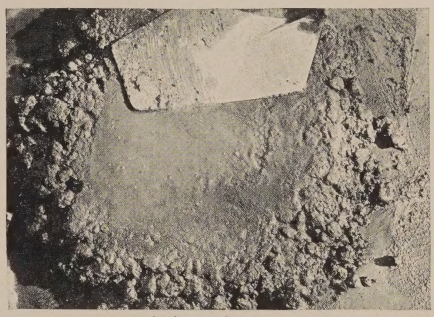
A good rule to follow is to so proportion the amounts of sand to pebbles as to obtain the greatest volume of concrete of plasticity suitable to the character of the work. Under no circumstances vary the ratio of water to cement from the quantities given in Table I.

Water Cement Ratio Strength Law The direct relation between strength of concrete and the relative quantities of water and cement in the mixture gives the water-cement ratio strength law which can be stated as follows:

> For given materials and conditions of handling, the strength of concrete is determined solely by the ratio of the volume of mixing water to the volume of cement so long as the mixture is plastic and workable.

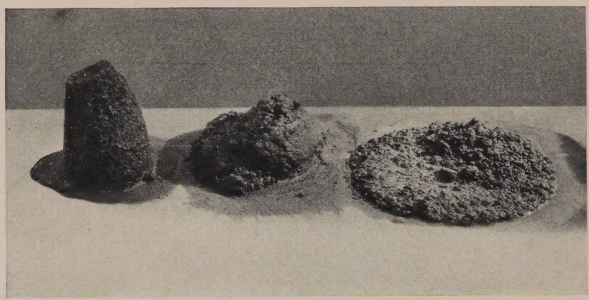


A concrete mixture in which there is not sufficient cement-sand mortar to fill spaces between pebbles. Such a mixture will be hard to work and will result in rough, honeycombed surfaces.



A concrete mixture which contains correct amount of cement-sand mortar. With light trowelling all spaces between pebbles are filled with mortar. Note appearance on edges of pile. This is a good workable mixture and will give maximum yield of concrete with a given amount of cement.

A concrete mixture in which there is an excess of cement-sand mortar. While such a mixture is plastic and workable and will produce smooth surfaces the yield of concrete will be low. Such concrete is also likely to be porous.

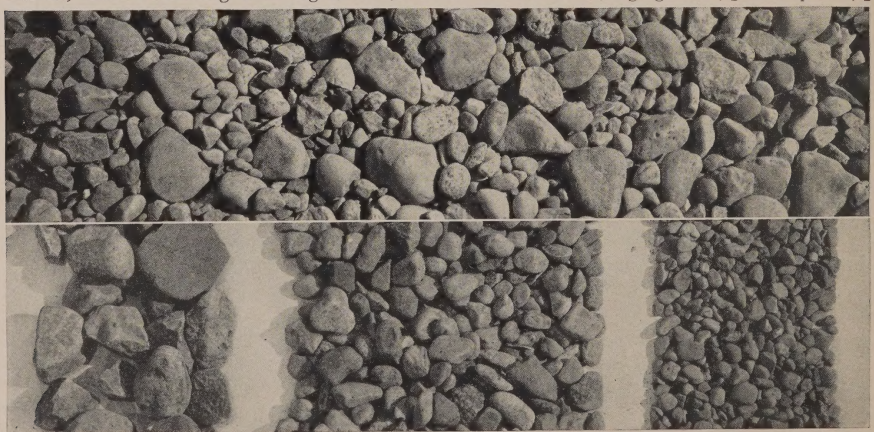


View, showing stiff, medium and wet mixtures of concrete. For foundation footing walls, pavements, floors and work of that character the stiff consistency is recommended. The medium mix will be found suitable for tank walls and floors, septic tanks, fence posts and similar construction. The wet mix is used only for work with very thin wall sections such as vases, flower boxes and garden furniture.

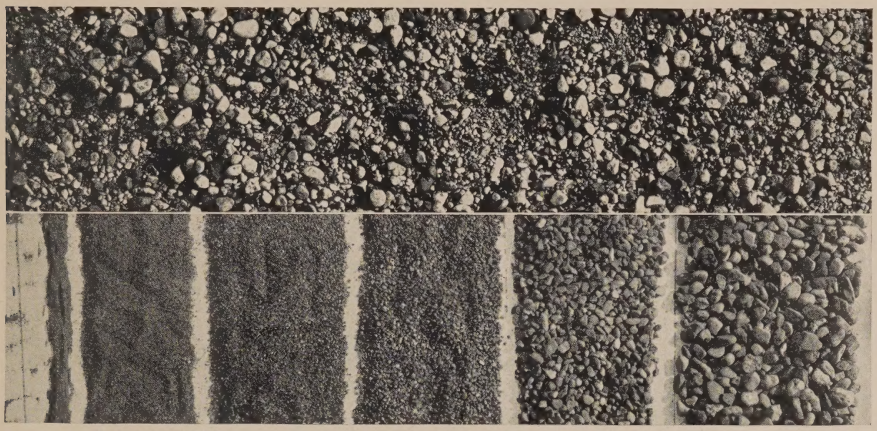
In other words, if 7½ gallons of water are used for each sack of cement in a mixture, the strength at a certain age is fixed, regardless of what quantities of aggregate are used, so long as the mixture is plastic and workable and the aggregates are clean and made up of sound particles. For example, under average control the use of 7½ gallons of water to one sack of cement and such amounts of suitable sand and pebbles as will give a workable mixture, will result in concrete having a compressive strength of 1,500 pounds per square inch when 28 days old. By using 6 gallons of water to the sack of cement, concrete having a strength of 2,500 pounds per square inch is produced. A 3,600-pound strength can be secured by reducing the amount of water to 4½ gallons to the sack of cement.

Watertight Concrete The ratio of water to cement also governs the watertightness or impermeability of the concrete. A workable mixture in which not more than 6 gallons of water have been used for each sack of cement will usually produce watertight concrete. The addition of more water increases permeability. Sloppy mixtures, unless containing a high cement content, are generally quite porous. Proper curing is also essential to obtain watertight concrete. Curing is discussed on page 11.

Aggregates Sand and pebbles or broken stone are usually spoken of as "aggregate." Sand is called "fine aggregate" and pebbles or crushed stone "coarse aggregate." Sand or other fine aggregate, such as rock screenings, includes all particles from very fine (exclusive of dust) up to those which will just pass through a screen having meshes ¼ inch square. Coarse aggregate includes all pebbles or broken stone, ranging from ¼ inch up to 1½



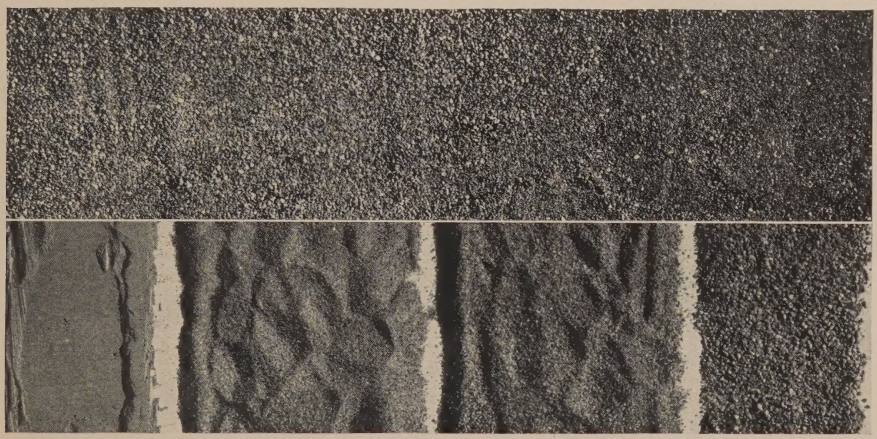
This is how a well graded coarse aggregate appears before and after being separated in three sizes. Reading from left to right, in the separated aggregate, ¾ to 1½-inch size, ⅜ to ¾-inch size, and ¼-inch to ⅜ inches. Note how the smaller pieces fit in between the larger ones in the mixed aggregate, thus producing a dense mixture.



Sample of well graded sand before and after it has been separated in various sizes. Particles vary from fine up to ¼ inch in size. Width of strips indicates amounts of each size. This is a good sand for concrete work.

or 2 inches. The maximum size of coarse aggregate to be used is governed by the nature of the work. In thin slabs or walls the largest pieces of aggregate should never exceed ⅓ the thickness of the section of concrete being placed.

Sand Sand should be clean and hard, free from fine dust, loam, clay and vegetable matter. These "foreign" materials are objectionable because they prevent adhesion between the cement and sound, hard particles of sand aggregate, thereby reducing the strength of the concrete and increasing its porosity. Concrete made with dirty sand or pebbles hardens very slowly at best and may never harden enough to permit the concrete to be used for its intended purpose.

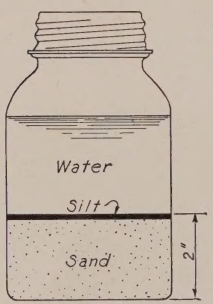


Sample of sand which lacks particles above 1/16 inch in size and how it looks when separated into four sizes. More cement is required when sand is fine. This is not a good concrete sand.

Sand should be well graded, that is, the particles should not all be fine nor all coarse, but should vary from fine up to those particles that will just pass a screen having meshes ¼ inch square. If the sand is well graded the finer particles help to occupy the spaces (voids) between the larger particles, thus resulting in a denser concrete and permitting the most economical use of cement in filling the remainder of the voids or air spaces and binding the sand particles together.

Coarse Aggregate Pebbles or crushed stone to be used in a concrete mixture should be tough, fairly hard and free from any of the impurities that would be objectionable in sand. Stone containing a considerable quantity of soft, flat or elongated particles should not be used.

Bank-Run Gravel The natural mixture of sand and pebbles as taken from a gravel bank is usually referred to as bank-run material. This is seldom suitable for concrete unless first screened so that the sand may be separated from the pebbles and the two materials reproportioned in correct ratio according to class of work. Most gravel banks contain either more sand or more pebbles than desirable for a concrete mixture. Usually there is too much sand.



An ordinary quart fruit jar may be used to make the silt test for sands.

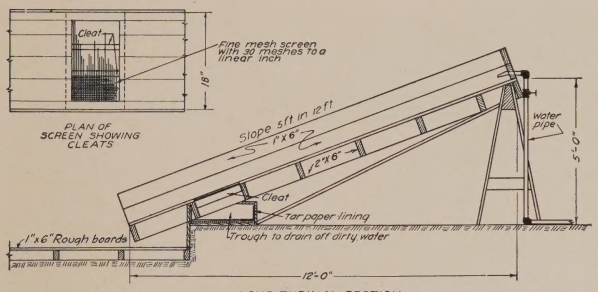
Testing Sand for Cleanness In a previous paragraph it was pointed out how particles of dirt interfered with the proper action of cement in hardening. Vegetable or organic matter is likewise objectionable. The silt test has been developed to determine whether excessively fine material called silt is present in sufficient quantities to reduce the strength of the concrete. The colorimetric test is used to detect the presence of harmful amounts of organic matter.

Silt Test The silt test is made as follows, using an ordinary quart milk bottle or quart fruit jar. Fill the jar to a depth of 2 inches with a representative sample of the sand to be tested. Add water until jar or bottle is about three-fourths full and shake vigorously for one minute, the last few shakes being in a sidewise direction to level off the sand. Allow the jar to stand for an hour during which time any silt will be deposited in a layer above the sand. If this layer is more than ⅛ inch thick the sand of which this sample is representative is unsuitable for concrete work unless excess silt is removed by washing.

Colorimetric test is used to detect presence of harmful amounts of organic matter in aggregates. A clear liquid as shown in the bottle on the reader's left indicates aggregate is free from organic matter. The slightly colored liquid in the center bottle indicates presence of some organic matter but not enough to prove injurious. The dark liquid in the right hand bottle shows that the aggregate is unsatisfactory for concrete work unless organic matter is washed out.

The Colorimetric Test for Organic Impurities The colorimetric test is not ordinarily made unless trouble is being experienced in getting concrete to harden properly. In sections where pine, oak and tamarack grow plentifully the sand may have become laden with injurious decaying humus by water leaching downward to a sand deposit beneath. Leaves, bark, sawdust and other vegetation forming tannic acid upon decomposing is particularly troublesome in this respect. The colorimetric test has been adopted by the American Society for Testing Materials and is a reliable indicator of the presence of harmful organic matter except in areas where there are deposits of lignite, which is coal in process of formation. The test will be found particularly valuable when locating a new sand supply on the farm.

In making the colorimetric test an ordinary 12-ounce prescription bottle, such as druggists or physicians use, is filled to the 4½-ounce mark with a sample of the sand. To this is added a



Design for a simple device for washing aggregates.

3 per cent solution of caustic soda* (sodium hydroxide) until the 7-ounce mark is reached. The contents are thoroughly shaken and then allowed to stand for 24 hours.

At the end of this time the color of the liquid will indicate whether the sand contains dangerous amounts of organic matter. A clear liquid indicates absence of organic matter. A straw colored solution indicates some organic matter but not sufficient to be seriously objectionable. Darker colors mean that the sand contains injurious amounts and should not be used unless washed and a retest shows that it is then satisfactory.

Washing Aggregates Sand or pebbles containing injurious amounts of silt or organic matter should be washed. A simple washing device is shown above. The materials to be washed are piled on the higher end. Water is applied by means of a garden hose, pail or other convenient means.

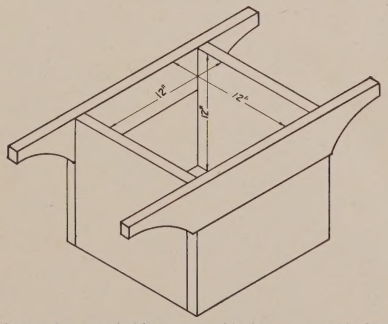
As the materials are washed down the incline, silt dust and organic matter separate out and are carried away in the water. It is a good plan to run check tests to see whether washing has been thoroughly done.

Water Water used to mix concrete should be clean, free from oil, alkali and acid. In general, water that is fit to drink is good for concrete.

Don't Guess at Quantities All materials including water should be accurately measured. Aggregates can easily be measured by using a box made to hold exactly 1 cubic foot, 2 cubic feet or any other volume desired. Such a box is in reality a bottomless frame. An illustration of a measuring box is shown below. To measure the materials the box is placed on the mixing platform and filled. When the required amount of material has been placed in it, the box is lifted and the material remains on the platform. Cement need not be measured because, as already explained, one sack can be considered as 1 cubic foot in volume. A pail might also be used in proportioning concrete. For example, a 1:2:3 batch of concrete would be measured by taking 1 pail of portland cement, 2 pails of sand and 3 pails of pebbles or stone.

DIMENSIONS FOR BOTTOMLESS MEASURING BOXES OF VARIOUS CAPACITIES

Capacity In Cubic Feet	Inside Measurements in Inches		
	Length	Width	Height
1	12	12	12
1¼	15	15	9⅝
1½	15	15	11½
1¾	15	15	13½
2	18	18	10⅜
2¼	18	18	12
2½	18	18	13⅜
2¾	18	18	14⅝
3	18	18	16



A bottomless box holding one cubic foot, two cubic feet or any other desired amount makes a convenient measure for proportioning sand and pebbles.

*A three per cent solution of caustic soda is made by dissolving one ounce of sodium hydroxide in a quart of water, preferably distilled. Sodium hydroxide may be purchased at any drug store at nominal cost. The solution should be kept in a glass bottle tightly stoppered. Handling sodium hydroxide with moist hands may result in serious burns. Care should be taken not to spill the solution, which is highly injurious to clothing, leather and most other materials.

A machine mixer will soon pay for itself in saving labor. Machine mixing usually means more uniform, better quality concrete

Mixing the Materials Concrete may be mixed either by machine or by hand. Machine mixing is to be preferred as in this way thorough mixing is easier to obtain and all batches will be uniform. However, first-class concrete can be mixed by hand. Whichever way mixing is done, it should continue until every pebble or stone is completely coated with a thoroughly mixed mortar of sand and cement.

Machine Mixing Practically all of the standard batch-type machine mixers on the market will render satisfactory service and will pay for themselves in a short time by saving labor and insuring more thoroughly mixed concrete. In case one person may not have sufficient work to justify the purchase of a mixer it is often possible to get several neighbors to share the expense of buying a machine which all may use. Names and addresses of mixer manufacturers will be furnished on request.

With a batch type machine mixer it is recommended that mixing continue for at least one minute and preferably for two minutes after all materials, including water, are placed in the mixer drum. On the completion of a job or of a day's work the mixing drum should be thoroughly cleaned. This is best done by scouring with water and pebbles.

Hand Mixing For hand mixing, a watertight platform at least 7 feet wide and 12 feet long should be provided. A platform of this size is large enough to permit two men using shovels to work upon it at one time. Such a platform should preferably be made of boards one or two inches thick, tongued and grooved so that joints will be tight and the platform rigid. These planks may be nailed to three or more 2 by 4's set on edge. Two sides and one end of the platform should have a strip nailed along the edge and projecting 2 inches above the mixing surface of the platform to prevent materials from being washed or shoveled off while mixing.

The usual procedure in mixing concrete by hand is as follows:

The measured quantity of sand is spread out evenly on the platform. On this the required amount of cement is dumped and evenly distributed. The cement and sand are then turned over thoroughly with No. 2 square pointed shovels enough times to produce a mass of uniform color, free from streaks of brown and gray. Such streaks, when present, indicate that the sand and cement have not been thoroughly mixed.

This mixture is spread out evenly over the platform and the required quantity of pebbles

or broken stone is then measured and spread in a layer on top. The materials are again mixed by turning with shovels until the pebbles have been uniformly distributed throughout the mixture of cement and sand. At least three turnings are necessary.

A depression or hollow is then formed in the center of the pile and the proper amount of water (See Table I) added slowly while the materials are turned in toward the center with square pointed shovels, this turning being continued until the cement, sand and pebbles have been thoroughly and uniformly combined and the desired workability and smoothness obtained throughout the mixture.

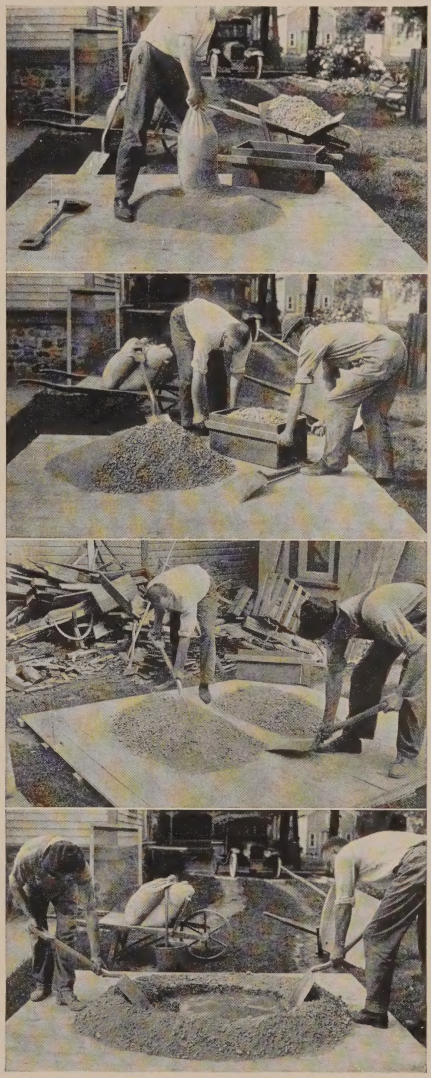
Placing Concrete Concrete should be placed in the forms as soon as possible, in no case more than 45 minutes after mixing. It should be deposited in layers of uniform depth, usually not exceeding 6 inches. When placed in the forms it should be tamped and spaded so as to cause it to settle thoroughly everywhere in the forms and produce a dense mass. By "spading" is meant the working of a spade or chisel-edge board in the concrete and between it and the side of the forms, moving the spading tool to and fro and up and down.

This working of the concrete next to the forms forces the large pebbles or stone particles away from the form face into the mass of the concrete and insures an even, dense surface when forms are removed.

Finishing Concrete The surface of a floor or walk should be finished by using a wood float. A metal trowel should be used sparingly, if at all, because its use brings a film of fine material to the surface, which lacks the wearing quality of the cement and sand combined and may cause the surface to develop "hair cracks" after the concrete hardens. A trowelled surface is smoother, but does not wear so well as a floated surface and is likely to be slippery.

Protecting Newly Placed Concrete—Curing If concrete is left exposed to sun and wind before it has properly hardened, much of the water necessary to hardening will evaporate and the concrete will simply dry out. Moisture is necessary to the proper hardening of concrete because, as already mentioned, this process is due to changes which take place in the cement when mixed with the proper amount of water.

Concrete floors, walks, pavements and similar large surfaces can be protected by covering with



Steps in the work of mixing concrete by hand. Thorough mixing is essential for satisfactory results.

Spading of concrete in wall forms forces the coarse aggregate back from the face and produces a smooth surface on the finished wall.

moist earth, sand, or other moisture-retaining material as soon as the concrete has hardened sufficiently to permit doing so without marring the surface. This covering should be kept moist in warm weather by frequent sprinkling during a period of ten days or so. Walls or other sections which cannot conveniently be covered in the manner suggested can be protected by hanging moist canvas or burlap over them and wetting down the entire work often enough to keep it always moist for 10 days after placing.

During cold weather protection is equally important, but the concrete need not be kept moist as evaporation is not so rapid.

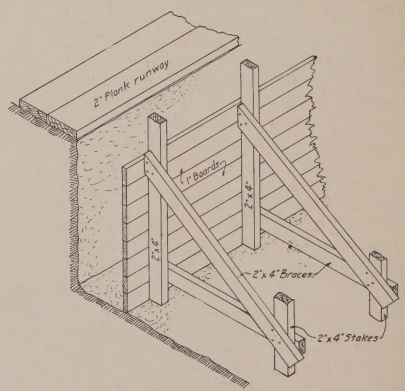
Forms Forms or molds are the receptacles in which concrete is placed so that it will have the desired shape or outline when hardened. Forms are generally constructed of wood and where a smooth surface finish is required, planed lumber is best.

Finished concrete will have no smoother surface than the forms. For rough work, forms can be made from rough lumber. For smooth finish work get dressed lumber, tongued and grooved or use shiplap so that the forms will be tight. Even for plain work, lumber that has been dressed at least on one side and on the edges is best because the boards will fit closely together and prevent leakage.

Forms may be built in sections or panels so constructed that they can be easily removed and used again or so that the lumber in them can be knocked down without injury and used in other work. Contractors often construct forms with special double headed nails or with screws instead of with the common wire nails. Forms should be so designed that they can be taken down with the least amount of hammering, thus preventing possible injury to the concrete before it has thoroughly hardened. A steel wrecking or stripping bar, obtainable at hardware stores or contractors' supply houses, is a useful tool for stripping wood forms from the finished concrete.

For foundation work below ground level, forms will not be necessary if the earth is so firm that the sides of the excavation will stand without caving. When placing and tamping the concrete, however, care must be taken not to knock down the earth into the concrete, as this would cause weak and porous spots in the wall.

To prevent adhesion of the concrete to the forms and make their removal easy, the forms should be well greased. Crude oil, oil drained from crank cases or soft soap is generally used for this purpose and is applied with a swab or brush. White wash is sometimes used as a substitute when oil or soap is not available. Forms



Forms for foundation walls where the embankment serves as the outer form.

should be cleaned of all concrete adhering to them from previous use and should be again oiled before re-using.

With ordinary skill in carpentry, anyone can make forms for common concrete construction, provided care is taken to build them strong and true. If properly designed, forms can be assembled in part by clamps and wedges, and only a few nails partly driven will be needed.

After forms are made they should be well braced in position so as to withstand the pressure and prevent bulging of the wet concrete while it is being tamped into place. Wood spacers should be used for walls to hold opposite form faces the correct distance apart, and wire ties passed through or around form studs and across the space between forms to tighten the forms against the spacers and hold them in true alignment so that the finished wall will be straight and even in thickness.

When built in sections, forms are easily erected and may be used many times.

Wire ties are tightened by twisting. Spacers must be removed as concreting progresses, as otherwise a permanent blemish in the wall will result.

Removal of Forms Forms must not be removed or "stripped" until the concrete has hardened sufficiently to permit doing so without damage. The time required cannot be definitely stated as so much depends on the nature of the work and local temperature and weather conditions.

In summer weather wall forms can generally be stripped after one or two days and in colder weather in from four to seven days. Floors over basements, roofs and other parts should not be stripped in less than seven days in summer and fourteen days in colder weather. If the concrete is still soft or yielding it should on no account be stripped, and if it has frozen it must be left in the forms until it has thawed and then watched to see whether it will harden properly.

Forms must never be removed until it is certain that the concrete has hardened sufficiently to be self-sustaining.

Reinforced Concrete Reinforcement is the term used to describe the steel rods or mesh that are placed in the concrete to increase its tensile strength. Concrete is a material that, like stone, is strong in compression—that is, very strong in bearing loads that are placed directly upon it. But it requires steel rods or mesh to increase its power to resist stresses or forces that tend to bend it or pull it apart. It is very important that this steel reinforcement be placed in the correct position; that is, in that part of the concrete mass where it will be most effective in resisting the tensile stresses.

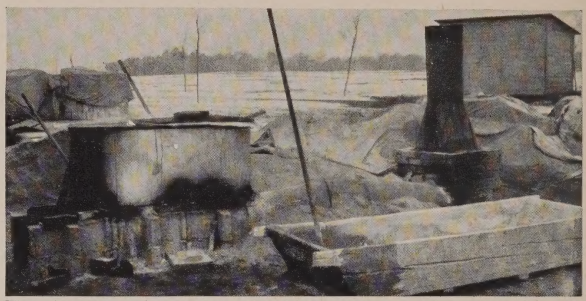
For example, in a concrete lintel or beam the reinforcement is placed near the lower side, as that is the side which tends to pull apart when the beam is loaded. The reinforcement of fence posts, troughs and stock watering tanks is explained in subsequent paragraphs. More important or elaborate structures such as floors above ground, beams, columns and retaining walls, should be designed by an experienced engineer.

Concrete Work in Cold Weather Concrete can be made during cold weather just as well as at any other time provided a few simple precautions are observed. Frequently it is advantageous to build in winter when labor is more plentiful and wages are often lower. Farm construction that can readily be completed in winter includes: concrete fence posts, concrete block, water troughs, milk cooling tanks, basement floors, foundations, septic tanks, floors and mangers in the barn and in fact floors of all kinds. In early winter when freezing occurs only at night, it is necessary merely to protect the concrete from freezing after it has been placed in the forms. As the weather grows colder and freezing temperatures prevail continuously, the mixing water and aggregate should be heated and the work protected.

Heating the Water The nearer the water is to boiling the better will be the results. Water can be heated in small metal tanks such as are used for watering stock or in a large kettle, such as that commonly used for butchering. Concrete should be mixed as

stiff as possible, and yet obtain a workable plasticity.

Heating Aggregates Several simple methods for heating sand and pebbles are commonly used. The materials may be banked over a metal barrel laid on its side, a section of smokestack or some other improvised heater, and a fire kindled inside. A satisfactory heater can also be made by building a fire-box of concrete block or brick with a sheet-iron cover on which the aggregates are piled. Sand and pebbles are heated separately to prevent them from becoming mixed. They should be turned frequently so that frost and ice are entirely thawed out before using. On large jobs it is customary to use steam for heating materials. Cement should not be heated.



Water for cold weather concreting is being heated in a metal stock watering tank supported on an improvised fire box made of concrete block. Sand and pebbles are heated by piling them on the flue between fire box and chimney.

Placing Concrete Frost, snow and ice, when present, must be removed from forms before concrete is placed. Concrete should be placed in forms immediately after it is mixed to prevent loss of the heat acquired by warming materials.

Protecting Concrete As soon as concrete has been placed it should be protected to retain as much heat as possible. Newly placed concrete walks, floors, pavements and other flat surfaces can be protected by covering with heavy paper and then with dry hay or straw or with manure, 10 to 12 inches deep. Outside walls can be protected by coverings of canvas or straw or by building enclosures around them and heating the interior with oil or coke stoves (the latter are commonly known as salamanders), or some other form of stove which will provide considerable heat without smoke.

Removing Forms Too early removal of forms must be carefully guarded against. Frozen concrete is frequently mistaken for properly hardened concrete. It may have the same "ring" when struck with a hammer. A reliable test is to apply heat or hot water to the surface. If frozen, it will soften on thawing.

Haul Materials Early Sand and gravel should be hauled in the fall before the pit freezes and stored under cover near the proposed job.

Heat Hastens Hardening Process Heat hastens the hardening of concrete; cold retards it. At about 80 degrees Fahrenheit concrete hardens rapidly. Below this temperature the rate of hardening decreases. When the temperature is around 50 degrees, the process of hardening is quite slow and at the freezing point ceases entirely. Concrete kept at a temperature of 60 degrees, or higher, soon hardens sufficiently to be safe against damage by frost. The warmer it is kept the sooner it will reach the point where frost cannot harm it. The general opinion is that 48 hours is sufficient if concrete can be kept above 60 degrees, but it is considered better practice to protect the concrete from freezing for about a week.

Sand is being heated by heaping it over a section of old smoke-stack in which a fire is built.

How to Figure Quantities

QUANTITIES OF CEMENT, FINE AGGREGATE AND COARSE AGGREGATE REQUIRED FOR ONE CUBIC YARD OF COMPACT MORTAR OR CONCRETE

MIXTURES			QUANTITIES OF MATERIALS				
Cement	F. A. (Sand)	C. A. (Gravel or Stone)	Cement in Sacks	Fine Aggregate		Coarse Aggregate	
				Cu. Ft.	Cu. Yd.	Cu. Ft.	Cu. Yd.
1	1.5	...	15.5	23.2	0.86	...	...
1	2.0	...	12.8	25.6	0.95	...	...
1	2.5	...	11.0	27.5	1.02	...	...
1	3.0	...	9.6	28.8	1.07	...	...
1	1.5	3	7.6	11.4	0.42	22.8	0.85
1	2.0	3	7.0	14.0	0.52	21.0	0.78
1	2.0	4	6.0	12.0	0.44	24.0	0.89
1	2.5	4	5.6	14.0	0.52	22.4	0.83
1	2.5	5	5.0	12.5	0.46	25.0	0.92
1	3.0	5	4.6	13.8	0.51	23.0	0.85

1 sack cement = 1 cu. ft.; 4 sacks = 1 bbl.
Based on tables in "Concrete, Plain and Reinforced," by Taylor and Thompson.

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESSES OF CONCRETE OR MORTAR

C. = Cement in Sacks.
F.A. = Fine Aggregate (Sand) in Cu. Ft.
C.A. = Coarse Aggregate (Pebbles or Broken Stone) in Cu. Ft.
Quantities may vary 10 per cent either way depending upon character of aggregate used.
No allowance made in table for waste.

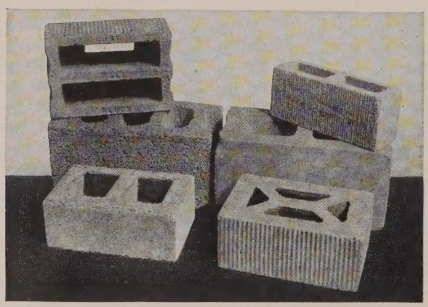
Proportion	1 : 1½			1 : 2			1 : 2½			1 : 3		
Thickness in Inches	C.	F.A.	C.A.	C.	F.A.	C.A.	C.	F.A.	C.A.	C.	F.A.	C.A.
⅜	1.8	2.7		1.5	3.0		1.3	3.2		1.1	3.4	
½	2.4	3.6		2.0	4.0		1.7	4.3		1.5	4.4	
¾	3.6	5.4		3.0	6.0		2.5	6.3		2.2	6.8	
1	4.8	7.2		4.0	7.9		3.4	8.4		3.0	8.9	
1¼	6.0	9.0		4.9	9.9		4.2	10.5		3.7	11.1	
1½	7.2	10.8		5.9	11.9		5.1	12.7		4.4	13.3	
1¾	8.4	12.6		6.9	13.9		5.9	14.7		5.2	15.7	
2	9.6	14.4		7.9	15.8		6.8	16.9		5.9	17.7	
	1 : 2 : 3			1 : 2 : 4			1 : 2½ : 4			1 : 2½ : 5		
3	6.5	13.0	19.3	5.6	11.2	22.4	5.2	12.9	20.6	4.6	11.5	23.0
4	8.6	17.2	25.8	7.5	14.9	29.8	6.9	17.1	27.5	6.2	15.4	30.7
5	10.8	21.6	32.2	9.4	18.7	37.4	8.6	21.5	34.3	7.7	19.2	38.3
6	12.9	25.8	38.6	11.2	22.4	44.7	10.3	25.8	41.2	9.2	23.0	45.9
8	17.2	34.4	51.6	15.0	29.8	59.7	13.7	34.3	54.9	12.3	30.7	61.3
10	21.5	43.2	64.4	18.7	37.4	74.8	17.2	43.0	68.6	15.3	38.3	76.6
12	25.8	51.6	77.2	22.4	44.7	89.4	20.6	51.6	82.4	18.4	45.9	91.8

CHAPTER II

CONCRETE MASONRY CONSTRUCTION

THE tremendous increase in the use of concrete block and concrete building tile for all classes of farm building construction makes it desirable for the property owner to acquaint himself with the advantages and methods of building with these units. Practically every community is within hauling or trucking distance of a concrete products plant or material yard where concrete block building tile are carried in stock.

In localities where it is not possible to obtain concrete block or building tile from products, plants or dealers, farmers will find it readily possible to manufacture their own concrete building units. Information as to where suitable machines and molds can be bought, as well as instructions on manufacturing method can be obtained on request.



Typical concrete building units. The larger units are concrete block, the smaller ones, concrete building tile.

Concrete Block Concrete block are made in several sizes and shapes. The standard 8 by 8 by 16-inch size is probably the most widely used. Laid up in single thickness it produces a wall 8 inches thick and courses 8 inches high. The 8-inch height is equal to 3 courses of brick. Block are also made regularly in the 10 and 12-inch widths with 8-inch heights and 16-inch lengths. Common types of block are shown on page 17.

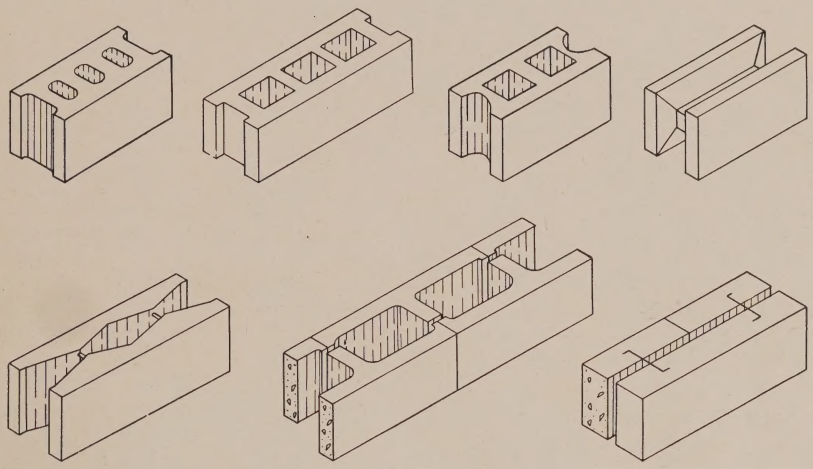
A block ordinarily spoken of as an 8 by 8 by 16-inch size usually measure $7\frac{3}{4}$ by 8 by $15\frac{3}{4}$ inches, allowance being made for $\frac{1}{4}$-inch horizontal and vertical mortar joints. Most block 16 inches in length are designed for $\frac{1}{4}$-inch joints, although

Trueness to size and shape make for rapid construction. Note broad mortar beds.

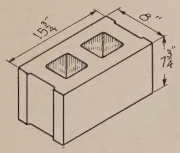
thicker joints may be used. Most products manufacturers and dealers carry half length block in stock making it unnecessary to cut them on the job if a little care is observed in designing the building.

It is a simple matter to lay out a building so that its width and length as well as distances between doors and windows are equal to a given number of full and half length block. For example a wall exactly 24 feet long will take 18 full length 16-inch block in each course; a wall 26 feet long will require 19 full-length and one, half-length block. Time is saved if the mason is not required to cut block and a more workmanlike job is secured.

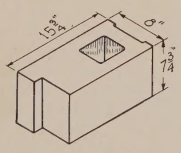
In the hollow and two-piece types of block the amount of air space varies from 20 to 40 per cent of their volumes, but in the most common



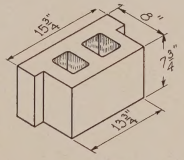
Common types of concrete block.



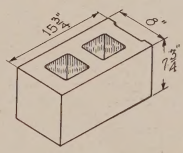
Standard size block.



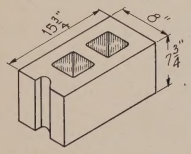
Jamb block.



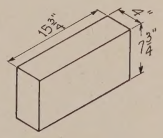
Joist block.



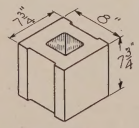
Corner block.



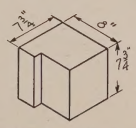
Jamb block for steel sash.



Veneer block.

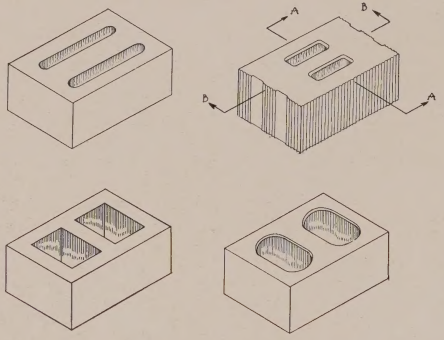


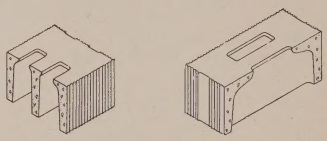
Half block.



Half-jamb block.

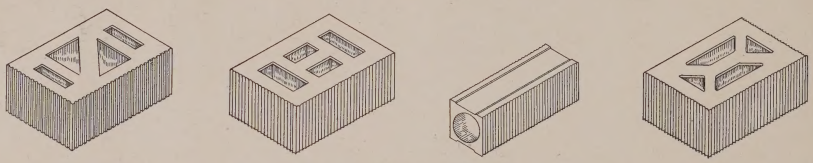
Standard size block with specials.



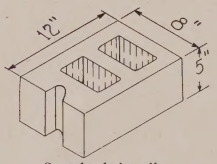


Section A-A. Section B-B.

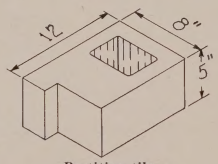
Typical sections of building tile.



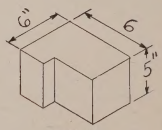
Types of concrete building tile.



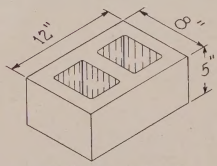
Standard size tile.



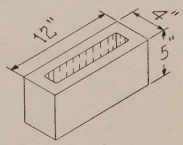
Partition tile.



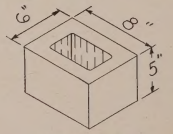
Half tile.



Jamb tile for steel sash.



Jamb tile.



Half-jamb tile.

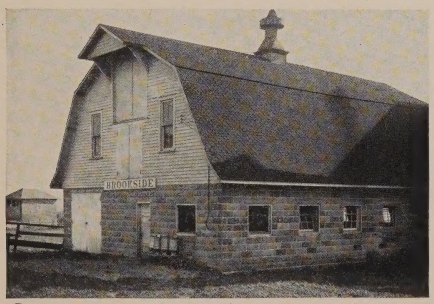
Standard size tile with specials.

types it averages around 33 per cent. Solid block are used where extra heavy loads are to be supported. These are produced by omitting the mold cores when block are made or by filling the air spaces with concrete after the units are laid.

Concrete Building Tile Concrete building tile are smaller in size and have somewhat thinner wall sections than block, the standard size being 5 by 8 by 12 inches. One such tile is equivalent in wall volume to 6 common brick. The height of 5 inches is equal to two courses of brick. Walls 8 or 12 inches thick are obtained by a single thickness of the tile, according to the way it is turned in the wall. The air spaces in concrete tile occupy from 50 to 60 per cent of their volumes. As in the case of concrete block, manufacturers regularly furnish half length units. Common types of concrete building tile are shown on page 18.

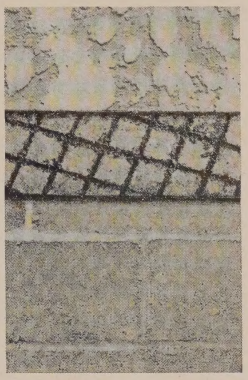
Special Block and Tile In addition to half length units, most manufacturers and dealers handling block and tile furnish corner block, joist block, door and window jamb block, sills, lintels and other specials. These enable the mason to lay up the wall more rapidly and to turn out a neater job. Common types of special units for block and tile construction are shown on pages 17 and 18.

Surface Finishes Most products plants carry in stock, rough, flat-faced block or tile for stucco covering and in addition one or two popular types of face block. For basement walls below grade the plain unsurfaced block is extensively used. For work above grade, the owner may select faced units or he may use the plain unsurfaced block depending on the class of work. For all farm buildings except the residence the plain unsurfaced block when carefully laid present a wall of satisfactory appearance. In the case of the farm dwelling it is customary to use faced units or apply a portland cement stucco finish over the block or tile as a backing.



Concrete masonry is ideal for the construction of dairy barn walls.

Concrete masonry provides an ideal backing for portland cement stucco. The surfaces of concrete block and tile are sufficiently rough to produce a strong mechanical key or bond for the stucco. So strong is the union between stucco and wall that it is practically impossible to remove the former without taking off part of the latter. Applied on a concrete block or tile backing, portland cement stucco is on to stay.

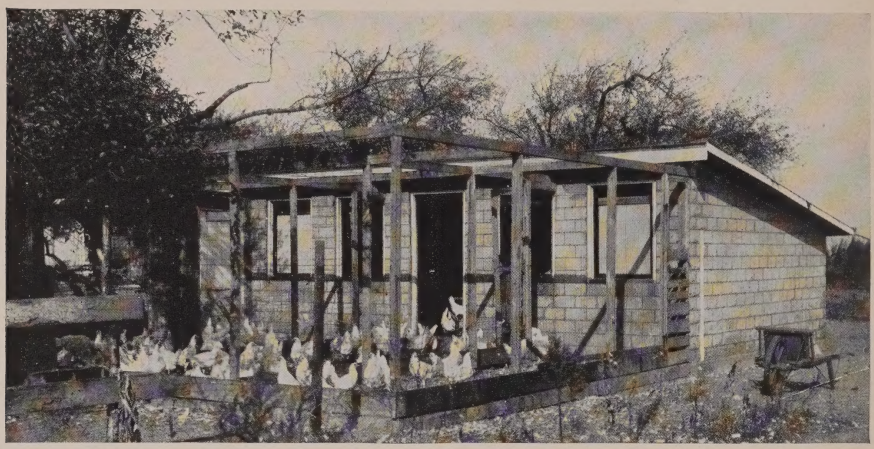

Section of concrete masonry wall showing second coat, also finish coat of portland cement stucco.

Wall Thickness of Concrete Masonry Buildings Eight inches is the usual wall thickness for poultry houses, hog houses, milk houses and the other smaller farm structures. Basement walls of barns are commonly made 10 or 12 inches thick. For 2-story residences, basement walls are generally made 12 inches thick and the walls above grade 8 inches thick.

Preparation of Mortar Portland cement mortar is recommended for laying concrete block and building tile because of its great strength, density and ability to resist weathering. Cement mortar should be made with clean well graded sand and clean water. Well slaked or commercially hydrated lime is usually added to make mortar more plastic or "fat." Commercially hydrated lime is carried in stock by most building dealers. Slaked lime is made by adding water to lump lime, which is also obtained from the dealer.

For ordinary work a mortar composed of one part portland cement, one part lime and not more than six parts sand, all measured by volume, is considered satisfactory.

Where extra strength and density are desired, as in building block water storage tanks, silos and similar structures a mortar consisting of one



A concrete masonry poultry house affords the farm flock a sanitary, healthful home.

sack of portland cement to 3 cubic feet of sand and 10 pounds of lime is recommended.

Mortar should be mixed thoroughly with just enough water to give the desired plasticity and workability. Thorough mixing improves the plasticity of mortars and less mixing water is required to obtain a workable consistency when time of mixing is increased.

The customary way of mixing mortar is by hand although machines are sometimes used for this purpose. Tools required for hand mixing are hoe, shovel and mortar box. Cement and sand are mixed together dry. If hydrated lime is used it can be mixed in with the cement and sand. When lime putty (slaked lime) is to be used, the lump lime is dissolved in water to a creamy consistency and is then added to the previously mixed cement and sand. Mix only enough mortar at one time so that the entire batch can be used before it begins to harden. Mortar that has partly set up should not be used.

Colored Mortars Only finely ground pure mineral pigments supplied by reliable manufacturers may be depended upon to produce thoroughly satisfactory colored mortars. The amount of mineral color should not exceed 10 per cent (by weight) of the cement used, as larger quantities may affect the strength of the mortar. Each batch of mortar must contain exactly the same proportions of cement, sand, coloring matter and water if exact color uniformity is to be obtained.

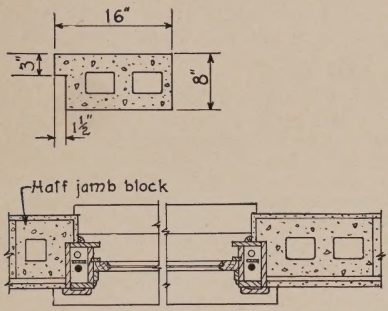
Mortar Joints The concave type of mortar joint is usually preferred for farm buildings. It is made by drawing a pointing tool along the joint after the mortar begins to stiffen. This operation compacts the mortar and produces a tight, water-excluding joint. Both vertical and horizontal joints are usually made from $\frac{1}{4}$ to $\frac{3}{8}$ inch thick. When the wall is to receive a portland cement stucco finish or is to be plastered, the mortar is struck off flush with the wall. Concave and flush mortar joints are shown in the accompanying drawing.

Concave mortar joints are ordinarily used for farm building construction except when walls are to be covered with portland cement stucco. Then the flush joint is recommended.

Concrete Masonry Wall Construction Two men generally work together in laying concrete block or concrete building tile. One man, called a helper, prepares mortar and brings it within easy reach of the other, who lays the block. The mortar is brought either in a hod which is carried on the shoulder or in a pail carried by hand. The hod is convenient when mortar is to be carried up a ladder. However, pails may be used and a rope

and pulley arrangement fixed up to raise mortar to the scaffold. The mortar is dumped upon a mortar board or laying board, which is a platform about 3 feet square constructed of boards.

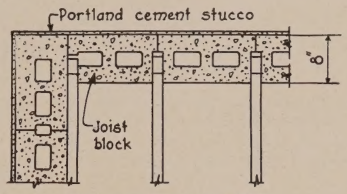
Corner block are often set first and chalk lines stretched tightly between them to serve as a guide in building a straight wall. These lines should be of stout cord such as cotton. Binding twine is useless for this work. If the corner block are accurately placed and plumbed and the line is not permitted to sag the wall will be



Weather-tight joints around door and window frames are obtained with jamb block.

plumb and true provided block are laid to this line.

Frames for doors and windows are set in proper position and built into the wall with special jamb block that abut against the frames. When floor levels are reached special "joist" block are set which have notches cut out for the joists. Another scheme is to use veneer block

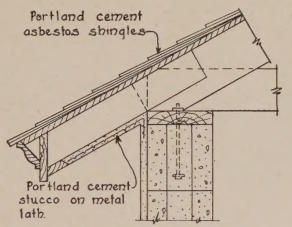


Common type of joist block.

on the outside wall, filling in between joists with similar shorter block.

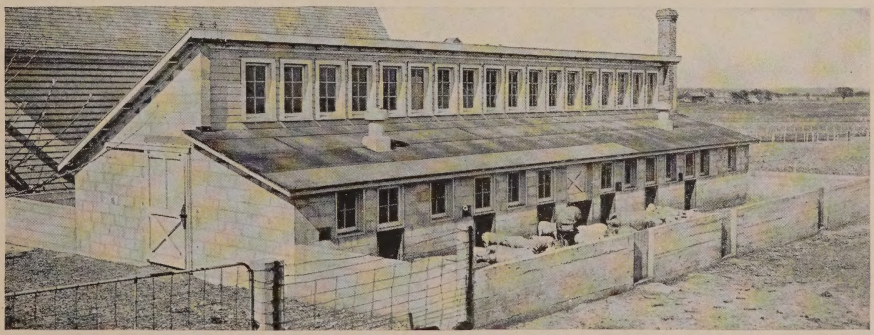
A basement wall is usually made thicker than the wall of the structure it supports. Then on the ledge or shoulder formed by change in wall thickness the first floor joists are set.

The usual method of attaching plates or sills to concrete masonry walls is to bolt them down



Plates and sills are attached to masonry walls with bolts.

at intervals, 6 feet apart or less, to the top course. Bolts should be long enough to extend through the plate and at least one course of masonry. Firmer anchorage is secured by slipping a large washer on the bolt and filling around the latter with concrete.



A sanitary, concrete masonry hog house is a great aid in making hog raising profitable.

CHAPTER III

SIDEWALKS, PAVEMENTS, FLOORS AND STEPS

Concrete sidewalks cut down housework by keeping mud from being tracked into the house.

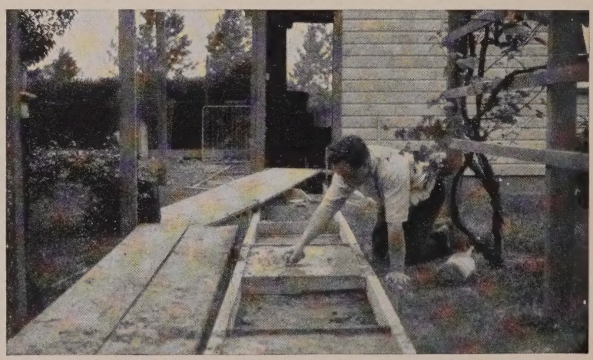
SIDEWALKS around the farm house are a necessity just as much as around the house in the city. Concrete walks keep the mud out of the house and protect the floors and rugs, making it easier to keep the house in order. Concrete walks between the different farm buildings are much appreciated in wet weather and are frequently used as runways for feed carts, wheelbarrows or other light farm conveyances.

Sidewalks should always rest on a firm base. If the soil on which they are to be laid is well drained, the concrete can be placed directly on it after all refuse, grass, roots and similar materials have been removed and the ground has been well compacted. If the soil is not well drained, a 6-inch sub-base of well compacted, clean, coarse gravel or clean cinders should be provided.

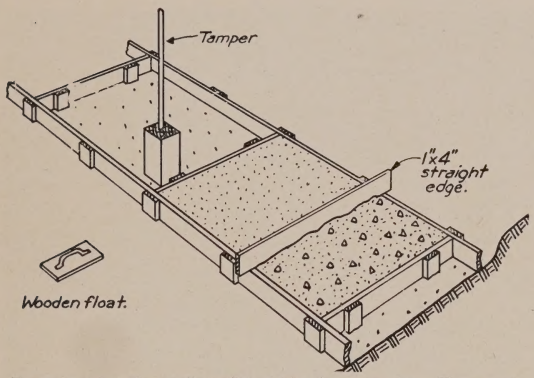
Thicknesses of walks may vary from 4 to 6 inches. If used only as a walk, 4 inches is generally thick enough; but if wagons or heavy vehicles are likely to be driven over the concrete, 6 inches is the minimum thickness. Where walks are to serve as runways for hauling feed, milk cans, etc., they are generally made about 3 feet wide. If used only for foot passage, a width of 2 feet may be sufficient.

Usually 2 by 4's are used for side forms, these being held in place by stakes driven along the outside. The top edges of the 2 by 4's are so placed that they serve as guides in levelling off the concrete. It is considered good practice to build walks about 2 inches above surrounding grade. In building a 4-inch walk this means that the area to be concreted will have to be excavated to a depth of 2 inches. If a 6-inch cinder or gravel fill is placed under the walk, excavation is then carried down 8 inches.

To make sure that water will drain off, the walk should be sloped toward one side; a pitch of $\frac{1}{4}$ to $\frac{1}{2}$ inch is satisfactory for a walk 3 feet wide. This is allowed for in setting the forms which, when brought to correct position, can be securely held in place by driving nails through the stakes into the 2 by 4's, allowing the nail heads to project about $\frac{1}{4}$ inch so that they may be easily withdrawn with a wrecking bar or claw hammer.



Concrete walks may be built as time permits, a few sections at a time.



Forms for sidewalks usually consist of 2 by 4's set on edge. These serve as guides in striking off the surface. For convenience, sidewalks are generally built in sections.

Walks are laid either as one-course construction or as two-course construction. One-course construction means that the full thickness of the walk is placed at one time, using the same mixture of concrete throughout. In two-course construction the walk is laid in two courses, using one mixture for the base and another (usually a mortar) for the top or wearing surface. One-course construction is generally the more satisfactory.

For convenience in building and to provide for expansion and contraction joints, walks should be divided at 4 to 6-foot intervals with partition strips placed at right angles to the side forms. Every other section is then concreted. After these have hardened enough to be self-sustaining, the cross strips are removed and the remaining slabs placed.

Another method which has some advantages in that it permits walks to be built continuously is to place strips of tarred felt against the header boards. When the header boards are removed these strips which extend entirely across the walk and for its full depth, remain permanently in position providing a definite joint between sections. In building walks by this method concrete is placed on both sides of the header board before it is lifted out. Then the pressure of concrete from both sides holds the tarred felt vertically, as it should be.

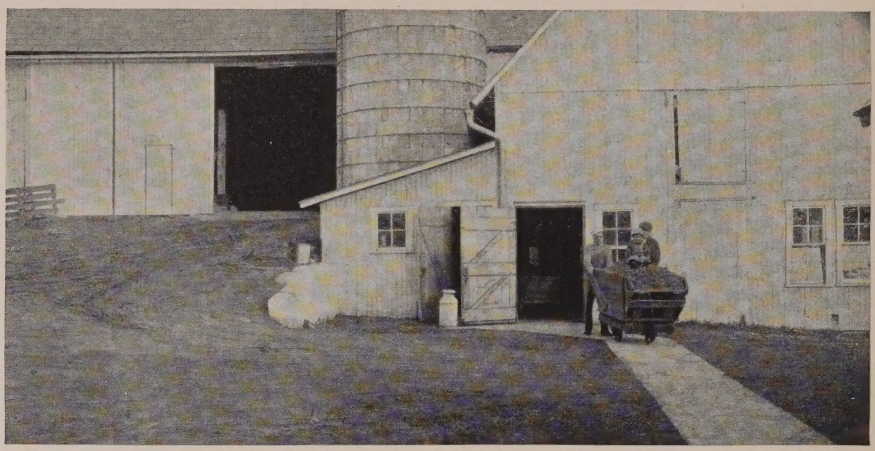
These methods of dividing a walk into sections to provide joints is superior to cutting through the concrete with a trowel prior to finishing.

For one-course construction, the proper mixture (see Table I, page 4) is 4¼ gallons of water per sack of cement, providing sand and pebbles are in a damp condition. If these are dry, the amount of water to add is increased to 5½ gallons. The trial mixture for the first batch is one sack cement, two cubic feet sand and three cubic feet pebbles (1:2:3 mix). If these amounts of sand and pebbles do not give a workable mix with the amount of water specified, change the proportions of sand and pebbles slightly, as described on page 5. In this way, the correct mix can be determined. Do not vary the amount of water from the quantity recommended.

The concrete mixture when of the right plasticity is easily levelled off with a strike board resting on the edges of the 2 by 4 side forms. This strike board should be passed across the forms with a saw-like motion, thus levelling the concrete, filling the hollows, and at the same time assisting to compact it. The walk should be finished with a wood float to produce an even, gritty surface. Avoid using a metal trowel because it produces a surface that is likely to become slippery and the excessive use of such a trowel may draw fine material to the surface, resulting in possible hair checking or crazing.

After the concrete has commenced to harden,

A concrete sidewalk gives pleasing appearance to the farmstead.



Concrete walks make convenient runways for feed carts and other farm operating equipment.

a covering of moist sand or earth about 2 inches thick should be put on and kept moist for 10 days or so. At the end of this time the covering may be removed and the walk put into use.

For two-course construction the correct mixture for the base course is 6 gallons of water per sack of cement to which is added suitable amounts of sand and pebbles to produce a rather stiff mix which is tamped into place. For the top or wearing surface, usually about 1 inch thick, a mortar composed of one part cement to two parts sand is used. Mortar top should be placed within a few minutes after the base has been tamped into place. As in the case of one-course construction, the surface is levelled off with a strike board, finishing is done with a wood float and curing is accomplished with a covering of moist sand, earth or other suitable material.

Concrete Driveways and Approaches

Nothing adds so much to the appearance of a farmstead, or creates such a good impression upon visitors as an attractive entrance. A concrete paved driveway not only makes the entranceway more inviting but insures that the approach to the farmstead will be passable 365 days of the year.

Easy to Build It is practically as easy to build a driveway as a sidewalk. Farm driveways are usually made from 8 to 10 feet wide, the latter width being preferable since it will readily accommodate most farm equipment.

Farm driveways are made not less than 7 inches thick so that they will safely carry trucks, tractors and other heavy loads. The center of the driveway is given a crown of 1 inch to insure rapid drainage. This crown is produced by means of a curved strike board or templet which shapes the surface so that the center is 1 inch higher than the outer edges. The area on which the pavement is to be placed should be brought to the desired grade, excavating or filling as may be required to secure uniform slope. All filled in places should be thoroughly compacted by tamping. The base is shaped with the center 1 inch higher than the outer edges so that the finished pavement will have a uniform thickness of 7 inches.

Forms For side forms, 2 by 6's or 2 by 8's may be used. These should be set so that their top edges will serve as guides for the templets in forming the crown. To provide expansion and contraction joints, the driveway should be divided off into sections 20 to 30 feet long. This

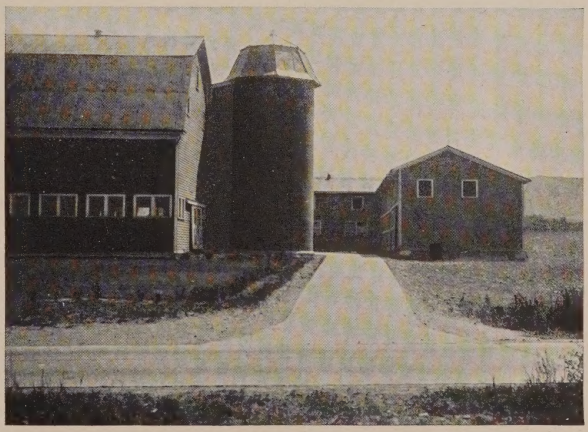
Entrance to the farmstead is made more attractive with a permanent concrete driveway.

is conveniently done by setting crosspieces at right angles to side forms as in sidewalk construction. Alternate sections are placed first and then the intermediate slabs. The driveway may be built continuously by using tarred felt strips for providing joints as described in sidewalk construction on page 23. One-course construction is recommended using the same mixture of concrete as specified for sidewalks on page 23.

Finishing Finishing is done with wood floats attached to long handles similar to those used in concrete highway construction. An old canvas or rubber belt 4 to 6 inches wide and 12 feet long will be found very helpful in producing a smooth, even pavement. The belt is drawn back and forth across the pavement, working forward slowly as the concrete surface is brought to the desired smoothness.

As in the case of the sidewalk, the new pavement should be protected from the drying action of the sun and the wind by covering with sand or earth which is kept moist by sprinkling. This covering should remain on for at least 2 weeks before the driveway is used.

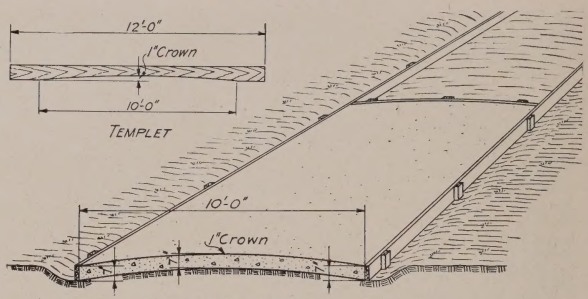
Concrete Approaches There is no better material for driveways to granaries, barns and other buildings than concrete. It possesses the necessary strength to withstand the hard usage common to such structures. For ordinary loads make the slab at least 6 inches thick; if heavy loads are to be carried the thickness should be 8 inches. Grooves can be cut in the surface with a trowel or can be



A concrete driveway insures year-'round access to the highway.

made by pressing triangular strips into the fresh concrete. Finishing is done with a wood float to give the even, gritty surface that prevents slipping.

It is often desirable to build an approach to the mow floor so that crops may be unloaded directly into the mow or bins. An earth fill is not satisfactory because it shuts light out of the stable and interferes with proper ventilation. The best method is to build a short earth fill and bridge the remaining gap with a reinforced concrete slab supported at one end by the stable wall and at the other by a wall to be built at the end of the fill.

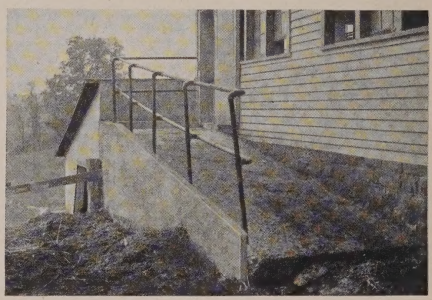


Design for Concrete driveway construction.

If the span is 10 feet, make the slab 6½ inches thick and use ⅝-inch reinforcing rods 8 inches apart. For 12-foot spans the slab should be 7½ inches thick and ⅝-inch reinforcing rods are placed on 6-inch centers. All reinforcing rods should be placed 1½ inches above the lower side of the slab. Alternate rods should be bent up at a point 2 feet from the edge of the support.

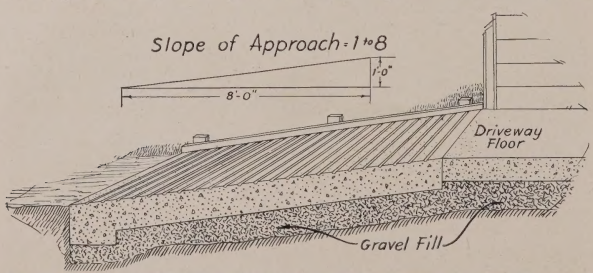
Reinforcing rods should be free from scale or excessive rust as this tends to prevent a close bond between the concrete and the steel reinforcement. Special care should be exercised that the steel rods are firmly imbedded in the concrete. See Table II on page 5 for correct proportions for work of this kind.

Concrete approaches provide sure footing for farm animals and are unbreakable.



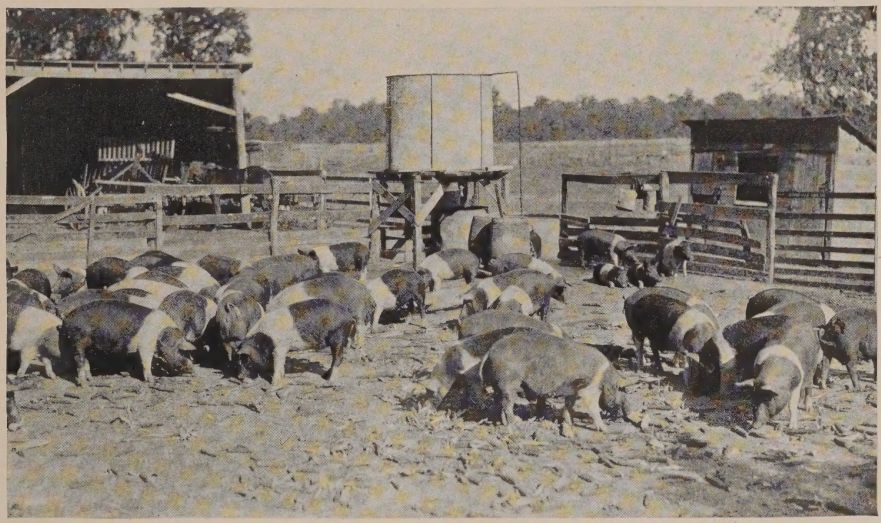
Concrete ramp to dairy barn.

For an approach with a span of 8 feet the slab should be made 6 inches thick and reinforced with ½-inch round rods placed 6 inches apart.



Concrete can best withstand the heavy usage given approaches to raised driveways. Grooving the surface as shown assures a firm foothold.

Feeding Floors for Hogs



Concrete feeding floors soon pay for themselves in feed saved. Hogs are also kept in better health.

One of the easiest improvements for the hog raiser to build is a concrete feeding floor. It is also one of the most profitable—it will bring him quicker and larger returns for the money invested than any other part of his hog raising equipment. In addition to saving all the feed, a concrete floor helps to keep the hogs in better health.

Location Time and labor will be saved if the feeding floor is located near the corn crib or granary.

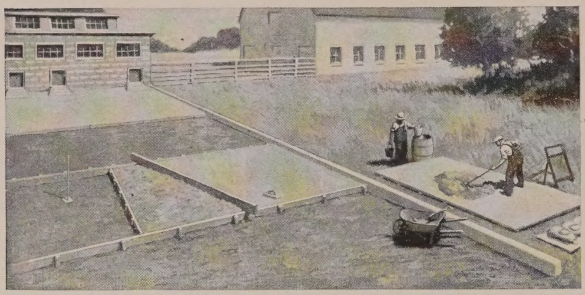
A location on the south or east side of the hog house or crib is desirable as the floor will then be largely protected from cold winds.

Where the ground is firm and well drained, concrete may be laid directly upon the soil after all refuse, grass, roots, and similar materials have been removed and the area brought to proper level and firmly compacted.

Construction Concrete feeding floors should be made not less than 4 inches thick. What is known as one-course construction, which means the same mixture of concrete throughout, should be used. The proper mixture (see Table I, page 4) is 4¼ gallons of water per sack of cement, using sand and pebbles in a moist condition. If these materials are dry, the amount of water to add to each one-sack batch is 5½ gallons. The mixture for the first trial batch is 1 part cement, 2 parts sand and 3 parts pebbles. It may be desirable to vary the amounts of sand and pebbles slightly as described on page 5 in order to obtain a workable mixture that will produce a smooth finish.

The floor should be sloped in at least one direction so it will drain quickly after rains. A slope of ¼ inch to the foot will be enough. The forms, usually 2 by 4's, are carefully set on edge in such position that they give the proper slope to the floor when concrete is struck off with a straightedge. Concreting may be done in strips just as concrete walks are made. Slabs should be about 10 feet square and joints between them should extend clear through to the subgrade. Finishing should be done with a wood float instead of with a steel trowel, so that the even gritty surface thus obtained will prevent slipperiness in all seasons of the year and provide a good substantial foothold for the animals.

A curb or apron like that shown on page 28 will prevent hogs from pushing grain off when feeding. This curb or apron should extend 12

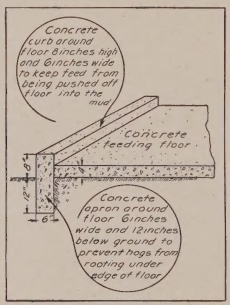


Sketch showing method of constructing concrete feeding floor.

inches below ground level to prevent hogs from rooting underneath the floor.

A few hours after concrete has been finished, the work must be protected by a covering of moist earth or similar material kept wet by sprinkling for about a week. Then the covering may be removed and the floor put into use. Wagons should not be driven over it, however, until it is at least 3 weeks old.

Frequently there is no time to get a feeding floor built until after silo filling and this may make it necessary to do some of the concrete work after cold weather sets in. The floor can be put in even though the nights are frosty, provided a covering of sacks or a heavy layer of straw is laid over the concrete to keep it from freezing.


Concrete curb around floor 8 inches high and 8 inches wide to keep feed from being pushed off floor into the mud
Concrete feeding floor
Concrete apron around floor 6 inches wide and 12 inches below ground to prevent hogs from rooting under edge of floor
6"
12"

Sketch showing concrete curb and apron construction.

Hogs weighing between 100 and 200 pounds need from 5 to 10 square feet for each animal. This will avoid overcrowding and prevent the smaller or weaker pigs from losing out at feeding time which is often the case when the feeding floor is constructed too small.

Size of Floor to Build

The following table will be found helpful in determining the size of floor required for different numbers of hogs. It also gives an estimate of the amount of cement, sand and pebbles needed based on a 1:2:3 mixture.

Number of Hogs	Minimum Sq. Ft. of Floor Required	Sacks of Cement	Cu. Yards of Sand	Cu. Yards of Pebbles
15	150	13	1	1½
30	300	26	2	3
60	600	52	4	6
90	900	77	5¾	8¾
120	1200	103	7¾	11¾
150	1500	128	9½	14½

Each 10 lineal feet of curb and apron require 2¼ sacks of cement, 4½ cubic feet of sand, and 6¾ cubic feet of pebbles. The foregoing is based on a 1:2:3 mixture and a floor thickness of 4 inches.

No corn is wasted on this concrete feeding floor. The crib overhead saves time in feeding and affords shelter for the animals in bad weather.

Concrete Paved Barnyards

Sanitary pavements of concrete are doing away with the unsightly mudholes once so common to barnyards. No matter how well an unpaved barnyard may be cared for, there are some seasons of the year during which it is not only muddy, but filthy. This results in dirty milk, because no matter how well stock may be cleaned they cannot be kept as clean if they must exercise in a muddy barnyard as when they have the advantages of a concrete pavement. In addition, the concrete paved barnyard prevents waste of manure.

Construction Anyone who has had even a limited amount of experience in concrete work can successfully undertake the construction of a paved barnyard by carefully following a few simple instructions. Not all the pavement need be built in one season, but a strip at least 20 feet wide should be laid adjoining the barn. Additional strips can be added as desired.

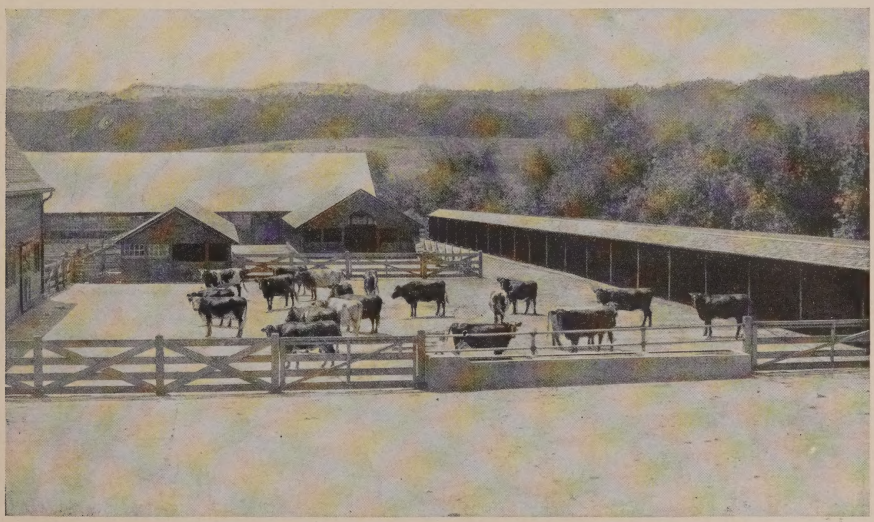
Either one-course or two-course construction may be used for barnyard pavements. However, the one-course construction in which the entire thickness of the floor contains the same mixture, is preferable. The same precautions in placing, aligning and bracing forms as described under Concrete Driveways should be observed.

Proportioning Concrete The recommended mixture for barnyard pavements is 4¼ gallons of water per sack of cement and such amounts of moist sand and pebbles as will produce a workable mixture. See Table 1, on page 4 and read instructions for making concrete, pages 3 to 14.

Slabs of a barnyard pavement should be limited to not more than ten feet square. Forms should be preferably of 2-inch lumber, 4 or 5 inches wide, depending upon the thickness of the pavement. The top of the forms should be set to such a grade that a slope of ¼ inch to the foot will be secured across the floor for proper drainage.

While a barnyard pavement must have an even surface so that it will drain freely and can be kept clean, it should not be finished so smooth as to make it slippery. If carefully and thoroughly finished by using a wood float, it will have the same gritty texture of surface secured by finishing a concrete floor in this manner and will thus insure a firm foothold for the animals.

Not all of the area which it is intended to pave need be laid out with forms at the same time. Forms for one row of slabs can be provided just as though a stretch of concrete walk were being laid.



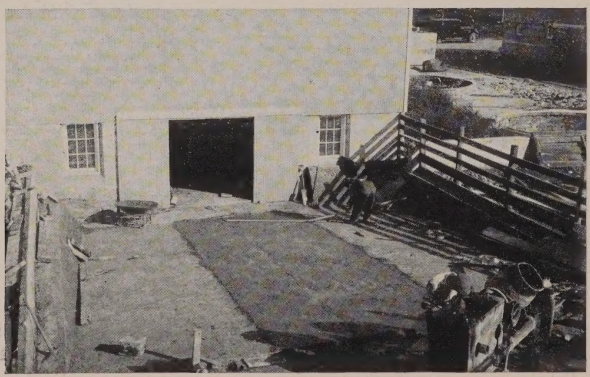
A concrete paved barnyard is clean and dry no matter what the weather may be. It saves valuable manures and makes an economical feeding place for stock of all kinds.

A concrete paved barnyard ends for all time wading through knee-deep mud and slush.

Then after marking this strip off into 10-foot squares, with crosspieces, every other slab is concreted and when these have hardened sufficiently the crosspieces are removed and the remaining sections placed. The operation is repeated for following strips, each of which serves as a form for one side of the strip next laid. Joints can also be made by placing tarred felt strips against header boards as in sidewalk construction, described on page 23.

Protecting Concrete While Hardening Just as soon as concreting has been finished and the concrete hardened enough to prevent if from being marred by a protective covering of moist sand or earth, such a covering should be applied and should be left in place and kept moist during the first 10 days so as to assist proper curing. Final results may not be entirely satisfactory unless this precaution to protect the work is taken.

After the 10-day interval has elapsed, the covering may be removed and the pavement put to use, although heavy wagons should not be driven over the concrete until it is at least a month old.



A few squares of pavement may be built at a time when other farm work does not interfere.

Materials A barnyard pavement subjected to heavy loads should be at least 6 inches thick, otherwise 4 inches will be sufficient. Based on a 1:2:3 mixture, it will require approximately 85½ sacks of cement, 6⅓ cubic yards of sand and 9½ cubic yards of pebbles to construct 1000 square feet of pavement 4 inches thick. For 6-inch pavements increase the quantities 50 per cent.

Poultry House, Hog House, and Other Farm Building Floors

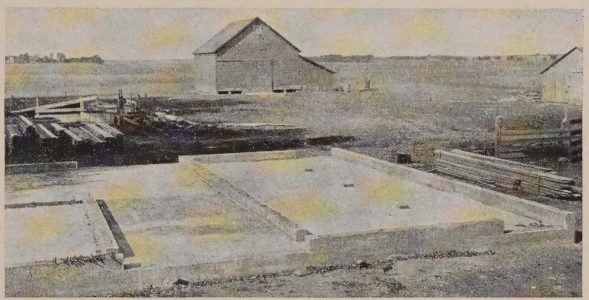
Concrete is the ideal material for building floors in poultry houses, hog houses, machine sheds, garages, milk cooling houses, corn cribs and other farm buildings. When constructed of concrete such floors are durable, sanitary and economical. They are easily constructed during spare time and will give life long service.

One of the first essentials of a floor, especially in poultry houses, hog houses and other structures where fowls or animals are housed, is that it remain dry at all times. While well made concrete is absolutely watertight it is usually considered good practice to place the floor on a fill which is at least 6 inches higher than the surrounding grade. This fill may consist of well compacted cinders, gravel, earth or a mixture of these materials. If the site on which the floor is to be located is poorly drained it is advisable to run a line of farm drain tile around the foundation so as to intercept water which might otherwise drain under the floor. Such a tile line should be placed about 2 feet below ground level and sloped toward the outlet to insure quick and complete drainage.

After the fill has been brought to the desired level and thoroughly compacted by tamping, forms are set for the concrete. Floors in poultry houses and other small buildings not subjected to hard service are generally made 4 inches thick, while in barns, hog houses, implement sheds and similar structures a thickness of 5 inches is considered satisfactory. For convenience in building, the floor is usually placed in strips or in sections using for forms 2 by 4's or 2 by 6's set on edge and held in place by stakes. Care is taken in setting the forms so that their top edges can be used as guides in striking off the concrete and bringing the surface to the proper level or slope.

A watertight mixture is recommended for floors and this is obtained by proportioning the amount of mixing water at the rate of 4¼ gallons for each one-sack batch when sand and pebbles are moist. (See Table 1.) However, if these materials are in a thoroughly dried condition 5½ gallons of water are added. The trial mixture for the first batch is 1 sack of cement to 2 cubic feet of sand and 3 cubic feet of pebbles. It may be necessary to vary proportions of sand and pebbles as explained on page 5 in order to obtain a dense workable mixture containing sufficient mortar to finish well.

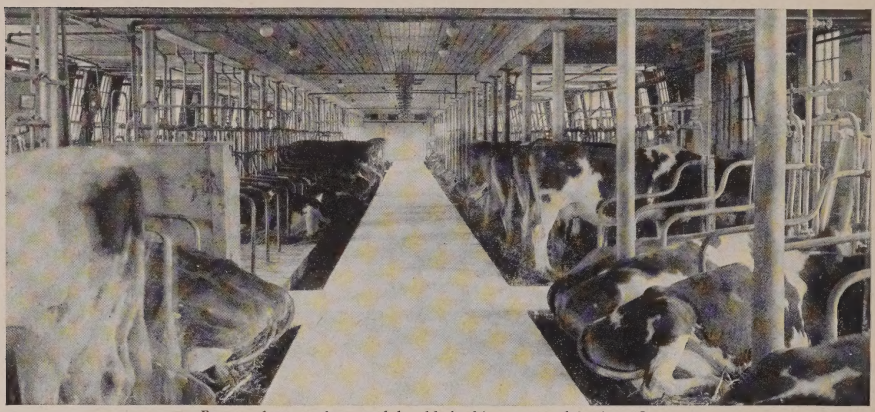
The mixture should be rather stiff, requiring some tamping to get it to settle into the forms. The full thickness of concrete is placed in one operation (one course construction, page 23). When forms are filled the surface is evened up and struck off flush with the top of the forms by means of a strike board which is worked back and forth, cutting off the high places, filling in the low places and bringing the surface to the desired level. The concrete is then allowed to stand until it has stiffened up sufficiently to permit finishing with a wood float. A steel trowel should be used sparingly as its use may result in an over-smooth floor which is likely to become slippery when wet. A smooth finish, however, is desirable for a poultry house floor so that fowls will not wear toes off in scratching.



Concrete provides ratproof, long-life floors for corn cribs and granaries. Such floors should always be built 6 inches or more above surrounding ground level to insure dryness at all seasons.

Proper curing increases both the hardness and water tightness of concrete floors. Usual practice is to keep all doors and windows closed and to keep surface moist for a week or 10 days by sprinkling. If floor is built out in the open, protection should consist of a covering of sand or earth kept moist for a like period, after which the floor can be put into service. In the case of corn cribs and granaries it is well to allow concrete to harden 6 weeks or longer before placing grain on the new floor.

Dairy Barn Floors and Mangers



Easy to clean, sanitary and durable is this concrete dairy barn floor.

The first step in the construction of a dairy barn floor is the removal of all rubbish and refuse from the area to be concreted. The surface is then brought to the required level, allowing, of course, for the thickness of the floor. The soil where the concrete is to be laid should be thoroughly compacted. If the location is such as to make it possible for water to get under the floor at any time, this possibility should be reduced by using a fill of clean gravel, cinders or crushed stone and providing suitable drainage for this fill. The gravel or cinder sub-base, if used, must also be thoroughly compacted and consolidated by tamping or rolling.

Forms for floor slabs, alleyways or other areas to be concreted should be of smooth lumber, rigidly braced in line and carefully set to proper grade. The manger curb is usually placed first. It should be not less than 5 inches thick and is usually made about 6 inches high on the stall side. Uprights supporting stanchions are of several types. Some are attached to anchors which are set in the curb, and others are embedded in the concrete. The latter type must be in line and carefully plumbed before placing concrete. One manufacturer has devised a clamp to bolt over the curb and support the stanchion.

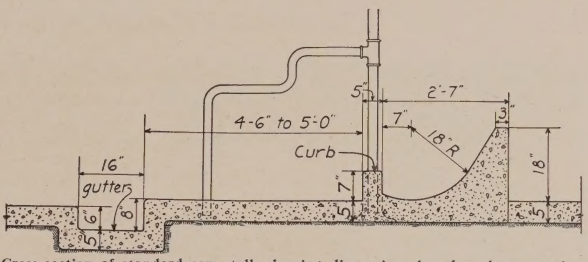
Feed and litter alleys are usually placed after the curb; then the stall platform and manger are placed.

The length of stall platform, that is, the distance from manger curb to gutter, will depend upon the breed of cattle kept. For Jerseys or Guernseys the average length is about 4 feet 8 inches; for Holsteins about 5 feet is necessary. The platform should be pitched about 1 inch

Building concrete mangers.

from the curb toward the gutter.

Where stall partitions are erected after the concrete platform is placed, holes about 6 inches in diameter must be left in the platform at intervals equal to the width of the stall, which is usually 3 feet 6 inches. After stall partitions are erected, these holes are filled with cement-mortar which is sloped up about an inch above floor level so as to drain liquids away from the steel, thereby protecting it from rust.



Cross-section of standard cow stall, showing dimensions based on best practice.

If stalls are to be paved with cork or other block, allowance must be made for the thickness of the block, plus ½ inch for cement-mortar in which they are embedded. In such cases, a 4-inch curb should be built on the gutter side.

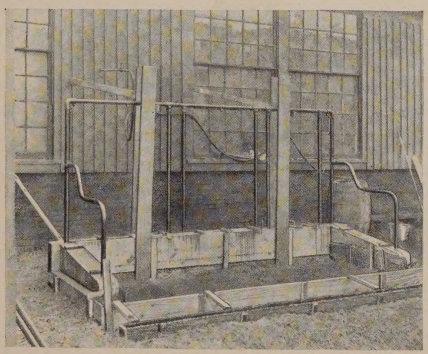
An illustration on this page shows in cross-section a design of dairy barn floor, stall and manger, based on best practice. By using a manger pattern or templet, the feed trough can be easily and evenly finished.

The mixture recommended for dairy barn floors and mangers is given in Table I, page 4. Also read carefully instructions on making concrete, presented on pages 3 to 14. One course construction is recommended, which means that the required thickness of concrete is placed in one operation.

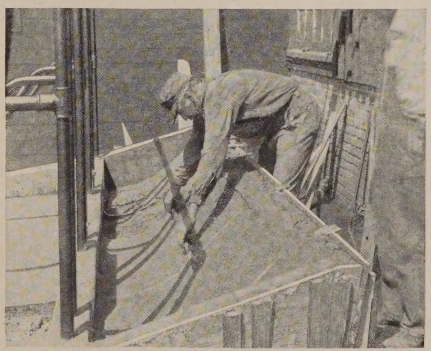
In mixing the correctly proportioned materials for one-course construction, only enough aggregate should be added to produce a mixture of quaky or jelly-like consistency with the proper amount of cement and water for this class of work. Concrete of such consistency can usually be settled into place and easily leveled with a strikeboard resting upon the top edge of forms. This should be passed across the surface with a saw-like motion and each time advanced a little, thus leveling the concrete and at the same time assisting to compact it.

The surface of the manger should be finished smooth with a metal trowel, with corners carefully rounded to make cleaning out easy and to provide a comfortable surface for the animals to eat from. Litter and feed alleys should be finished with a wood float to secure an even but gritty surface, thus providing secure footing for the animals. Alleys should be pitched ¼ inch to the foot toward a gutter connecting with a drain leading to a concrete manure pit or cistern unless absorbents such as straw are used.

Concrete dairy barn floors are easily built in summer or winter. In cold weather provision should be made for heating the room in which the floor is being laid until the concrete has hardened.



Forms for manger curb and for stall platform are in place ready for the placing of concrete. Stall floors are finished with a wood float to obtain a smooth non-slippery surface.



Templets for producing mangers are furnished by manufacturers of stall equipment. Manger is finished with a metal trowel to produce a smooth surface for the cows to eat from.

Basement Floors of Concrete

Permanent easy-to-clean concrete basement floors are standard construction in all modern farm residences. Where old dwellings are being modernized the installation of a durable concrete floor in the basement usually is given first consideration.

Construction Basement floors in houses are ordinarily made 4 inches thick, using either the one-course or two-course method of construction. The one-course method will generally prove most satisfactory and is recommended. The area to be concreted is excavated or filled as may be required. In the latter case the newly filled area should be thoroughly compacted by tamping. Wetting the earth used as filling will aid in securing a well compacted base.

Before building the floor, some thought should be given to drainage. The best time of course to make a basement dry and watertight is at the time the house is built. When the house is located where the water table in the soil is likely to rise above the level of the basement floor, it is advisable to run a line of drain tile around the outside of the footing as shown above.

A line of concrete drain tile placed on the outside of the footing assures a dry basement.

If the house is already built, it may not be very convenient to place the tile line around the outside. Then the next best procedure is to place the tile just inside the footing and slightly below it. Tile must be provided with a suitable outlet and should be laid to a uniform grade to insure that water will not stand in any part of the line. Farm drain tile 4 inches in diameter are commonly used for this purpose. A back filling of cinders or pebbles will increase the effectiveness of the drainage system.

For convenience in building, the floor is usually laid in strips 4 or 5 feet wide extending the full length or width of the basement. For forms, 2 by 4's are set on edge and so positioned that they provide grounds or guides for the strike board in levelling off the surface. Stakes are driven along the 2 by 4's to hold them in place. The recommended mixture for basement floors is 4¼ gallons of water per sack of cement with sufficient amounts of moist sand and pebbles to produce a rather stiff mixture. (See Table I and read directions for building a sidewalk.)

After concrete has been placed and levelled off with strike board the surface is floated to fill in low places and work down high spots. A little mortar composed of 1 part cement to 3 parts of sand may be used if necessary to obtain a dense even surface. Do not use a metal trowel for finishing unless a slick surface is wanted. If floor is to be pitched toward a drain, this should be provided for in setting the 2 by 4's.

The finisher in working the concrete will find short pieces of plank useful in working over the fresh concrete. Some finishers prefer to work from a bridge consisting of a plank supported so that it just clears the surface of the concrete. After the surface is evened off, the concrete is allowed to stiffen until ready for the final trowelling. Too much trowelling is not advisable.

If the soil is water-logged, care should be taken to make a tight joint between the floor and the wall. Strips of beveled siding well oiled are placed where the walls and floor meet. They are taken out as soon as the concrete has hardened and the joint filled with hot tar.

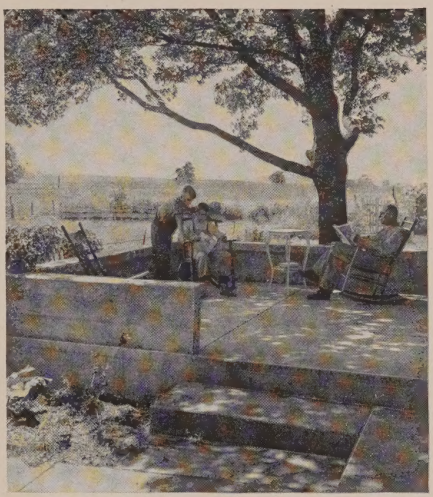
When it is desirable to continue concreting without stopping, the forms are removed only after the adjoining strip has been placed, struck off, and finished. The spaces left by the removal of the forms are then filled with concrete and finished the same as the strips on either side.

While concrete is curing, windows and other entrances to the basement should be kept closed and the surface sprinkled or flushed with water occasionally for several days.

Porch Floors

The easy-to-clean features of concrete porch floors meet with real approval from the housekeeper. Because concrete is rot-proof, porch floors of this material successfully resist exposure to all kinds of weather. Once built, porch floors of concrete are there to stay.

Porch floors are as easy to build as sidewalks; in fact the principles of construction are much the same. A well compacted sub-base is very essential so that there will be no further settlement after the concrete is placed. If the soil on which the floor is to be laid is well drained, the concrete can be placed directly on it after all loam, refuse and other perishable material have been removed and the area has been well compacted. If the soil is not well drained, a sub-base should be provided of well compacted, clean, coarse gravel or clean cinders. The same mixture of concrete is used as for sidewalks, and finishing and curing are done in the same manner, using a wood float to produce a smooth, yet gritty, slip-proof surface. Porch floors are usually given a pitch of ¼ inch to the foot to insure good drainage away from the house. Where the porch is enclosed with concrete walls, the floor is sloped toward the steps. Unless suitable shade is available, a roof is usually provided.

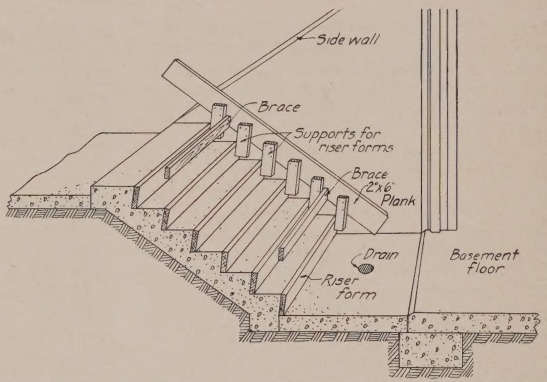


Porch floors of concrete are easily kept clean and last indefinitely, without repairs or replacement. They can be readily constructed by the farmer in his spare time.

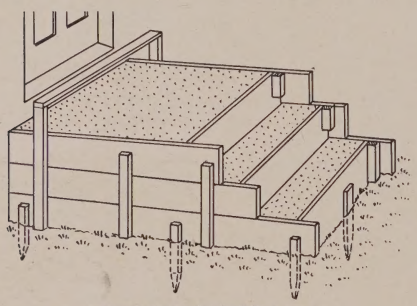
There is solid comfort on a cool, clean, concrete porch such as this, which was built by the owner. The railing around the porch is also of concrete.

Concrete Steps

The first place in the house to wear out and decay is the flight of outside wooden steps. Concrete steps are safe, non-slippery in wet weather, and last indefinitely. Every house should have them, they are easily kept clean and are absolutely rot proof. Simple forms for building them are shown in a drawing on this page. Either 1-inch or 2-inch lumber may be used for forms, whichever is available. The standard mixture for this class of construction is given in Table I on page 4. Concrete should be of a rather stiff consistency and contain sufficient mortar to produce smooth, even surfaces. Finish with a wood float so as to produce a smooth yet gritty surface. Curing should be done in the approved manner. (See page 11.)



Concrete basement steps are not hard to build. Simple forms for this work are shown in this sketch. Concrete in the steps should nowhere be less than 6 inches thick.



Simple forms for building steps.

Where steps are built with side walls the latter are placed first, using the same type of forms as in the construction of foundation walls. When side walls have hardened, forms are removed and the space under the steps is then filled in with earth and thoroughly tamped to provide a firm base on which to place the concrete steps. Steps of this kind, resting on well-compacted earth, require no reinforcement. Details of form construction for steps with side walls are shown in an accompanying illustration.

Flanks for supporting riser forms are held firmly in place against the previously built side walls by means of 1 by 4 braces. To the planks are nailed 1 by 4 pieces for holding riser forms in place. These supports are of such length that they come within 2 inches of the treads. Cross-pieces, usually of 1-inch material and 8 inches wide, are nailed to these to make riser forms.

For a comfortable flight of stairs the vertical distance from one step to the next should not exceed 7 to 7½ inches. The width of the tread should be about 10 inches to insure adequate footing.

Concrete steps last indefinitely. The hard surface of concrete is easily kept clean.

CHAPTER IV

CONCRETE FOOTINGS AND FOUNDATIONS

A WELL constructed concrete foundation insures uniform distribution of the weight of the building on the soil, preventing settlement and cracking of walls, reducing maintenance and repair costs, and prolonging the life of the building. Concrete foundations are uninjured by freezing, thawing or other weather changes. They are also ratproof, fireproof, economical and permanent.

Types of Foundation Walls

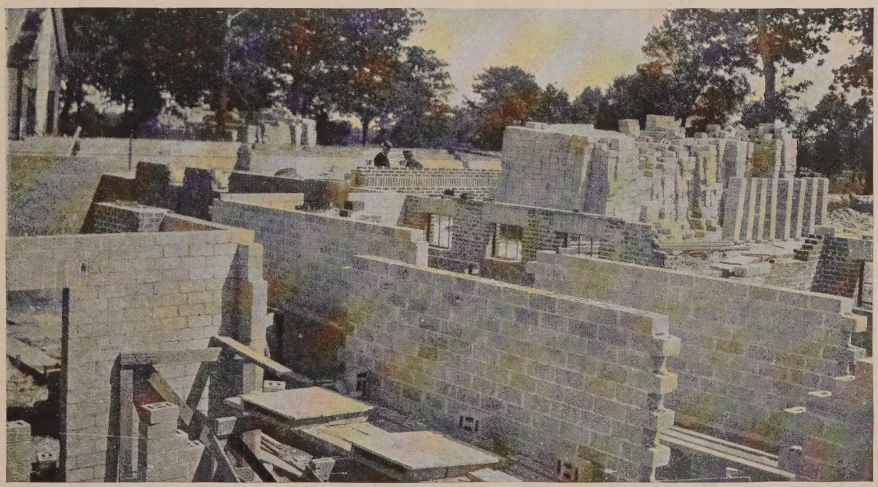
Concrete foundation and basement walls are of two types, those made of concrete cast in place and those built of precast units, known as concrete masonry. Both types are satisfactory. The usual practice is to lay monolithic concrete footings for all types of foundation walls. They are easy to build and insure uniform distribution of the weight of the building on the soil. They provide an even surface on which to start building the wall proper whether block or monolithic.

Dimensions of Foundation Walls and Footings of Small Buildings

Under the basement walls of a barn, a concrete footing 2 feet wide and 12 inches deep will usually be sufficient. Small residences generally require footings 18 inches wide and 12 inches deep. Footings 12 inches wide and 8 inches deep will serve for farm buildings such as hog houses, poultry houses, milk houses, ice houses and other buildings of that size.

A foundation wall 8 to 12 inches thick is generally ample for structures not more than two stories high. Small structures such as poultry houses, milk houses and garages require foundation walls from 6 to 8 inches thick. Basement walls for small and moderate sized residences are generally made from 8 to 12 inches thick.

For all types of buildings it is essential to extend the foundation below possible frost penetration even though firm bearing soil is found at

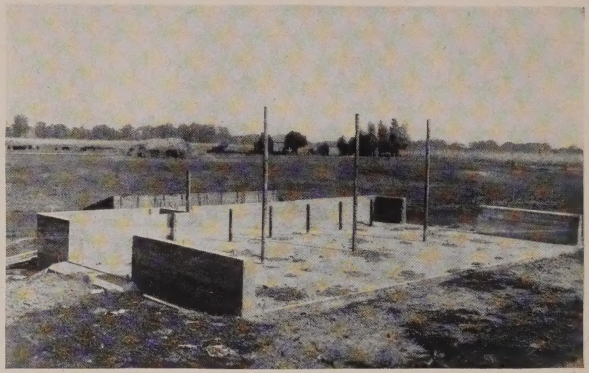


A typical concrete block foundation in the course of construction. This kind of foundation may be built quickly and at a minimum of expense.

a shallower depth. Then the foundation will not be upheaved by freezing.

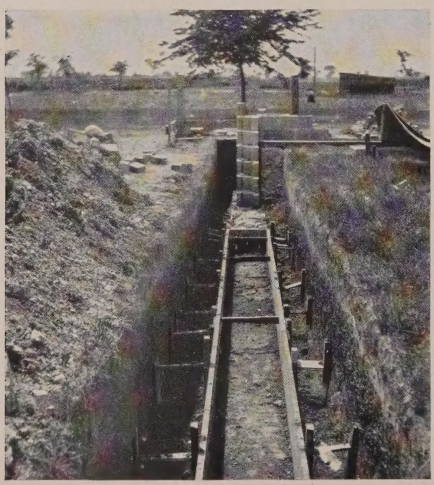
The following table indicates the safe loads for various soils:

Soft clay	1 ton per square foot
Wet sand	2 tons per square foot
Firm clay	2 tons per square foot
Fine and dry sand	3 tons per square foot
Hard dry clay	4 tons per square foot
Coarse sand	4 tons per square foot
Gravel	6 tons per square foot



A sanitary, permanent wall is formed by carrying the foundation of this hog house three feet above grade.

Earth Forms In building foundations for small structures without basements, the earth walls of the foundation trench may be so firm as to make it unnecessary to use specially built forms for the part of the wall below grade. The trench should be excavated carefully so that the sides will be even and vertical, and care should be taken not to knock earth into the trench when depositing or spading the concrete mixture. Planks laid alongside the trench will help to protect the edges and provide a convenient runway for wheel-barrows. In soft caving ground and for walls above ground, forms are required.



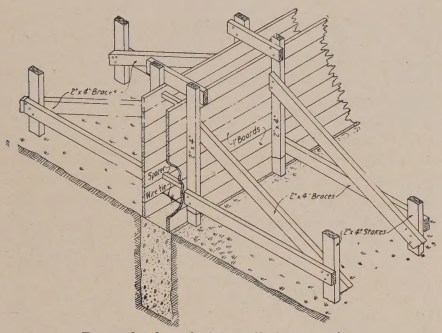
Forms for concrete footing in place.

Wood Forms Forms should be rigid and well braced in order to withstand the pressure of wet concrete and produce a straight, even wall without bulges or depressions. Posts and studs for supporting form boards or sheathing must be sufficiently stiff and strong to hold forms in true line. For keeping inside form surfaces the proper distance apart, inner and outer sections should be clamped or wired together, against wood "spacers" or "spreaders" of a length equal to the desired wall thickness. The spreaders are removed as the forms are filled with concrete.

Forms should be built so that if it is desired to use them again or to employ the lumber for other work, they can be "knocked down" with least injury to the lumber. To prevent concrete from sticking to the forms and to aid in their removal, the surfaces against which concrete mixtures will come should be oiled or greased.

Concrete Mixtures If the foundation wall is to form part of the enclosure of the basement or cellar, the recommended mixture is 5 gallons of water per sack of cement to which such amounts of moist sand and pebbles are added as will produce a rather thick consistency. (See Table I on page 4 and read directions for proportioning on pages 4 and 5.)

Concrete should be placed in the forms in layers of from 6 to not more than 10 inches deep and in a continuous operation if possible to avoid construction seams. Concrete should be well spaded



Form for foundation wall above grade.

next to form faces to obtain smooth, even surfaces.

If it is necessary to stop work before a wall can be finished, the concrete should be levelled in the forms and the surface roughened by scratching it or by placing large pebbles in it projecting about half way out of the concrete. This will help to secure a good bond between old and new layers of concrete when work is resumed.

Before depositing an additional layer of concrete, the roughened surface of old concrete should be scrubbed to remove any dirt or scum, just before placing new concrete. It should then be painted with cement and water mixed to the consistency of thick cream.

Concrete Masonry Basement Walls

Concrete block and building tile are now in common use for the construction of basement walls. They may be laid up quickly and economically because the units are relatively large, and uniform in size and shape. No forms are required. The air spaces in the units help to provide dry walls as well as to effect a saving in concrete and to make the units lighter and easier to handle.

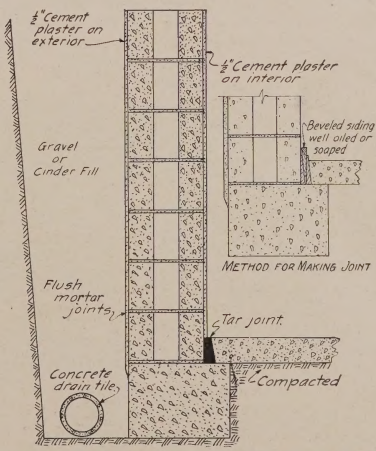
For the foundation wall below grade, smooth faced unsurfaced block are used. Unsurfaced block are also used above grade when the wall is to be stuccoed. Block having smooth faces or special facings of selected aggregates may be used for above grade work if stucco is not to be applied. Complete instructions for laying concrete block and tile are given on pages 16 to 21.

Constructing a Watertight Basement

The time to make a basement wall watertight is when it is built. It costs less to build a watertight wall than to repair a leaky one later. If properly made according to instructions in previous paragraphs, a concrete wall is water tight. However, it is not always easy to get first class workmanship and when the foundation is located in heavy, water-logged soils, water may find its way through construction joints. To allow for the possibility of defective workmanship it is well to observe the following precautions. Similar methods are used for repairing leaky basements and for insuring watertightness in basements built of concrete block or concrete building tile.

In each case a line of drain tile is placed entirely around the outside of the footing and is connected to a suitable outlet. The excavation above tile is filled to within a foot of grade line with gravel, cinders or some other material of a porous nature to provide a fill that will allow water to seep through quickly. When the foundation is erected so near another building that it is impossible to run a line of tile around the outside, the tile may be placed on the inside of the footing and slightly below it. When there is considerable water in the soil, it is often advisable to place lines of tile both inside and outside of footings.

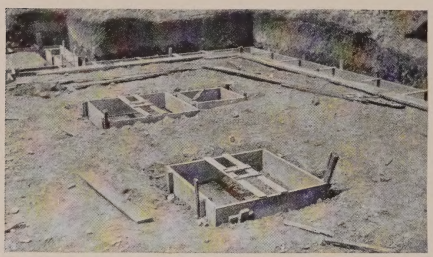
As a further precaution in securing a dry basement, two or more coats of cement plaster mixed in the proportion of 1 sack of portland cement to 2 cubic feet of clean sand may be applied to the exterior surface as soon as wall forms are removed, or in the case of a concrete masonry wall just as soon as the mortar joints have hardened.



Cross section of a basement wall which has been made watertight by cement plaster coatings and drain tile around the footing.

The wall surface should first be thoroughly dampened. A similar coating may be applied on the inside surface if desired.

Another common method of wall treatment is to coat the exterior surface with hot tar, pitch or



Forms in position for the footings upon which are carried the concrete piers supporting the interior.

suitable asphaltic preparation, using a broom or fiber brush. The wall must be clean and dry when this coating is applied, otherwise it will not adhere. The cement plaster treatment is generally the most satisfactory method.

Walls Above Ground Walls above ground, either monolithic or concrete masonry, are built in a similar manner to basement and foundation walls. Frames for doors and windows may be set before walls are built or they may be inserted after walls are completed. In the first case the frames are carefully set in the forms before concrete is placed. Spikes are partly driven into backs of frames so that when concrete is placed they will be securely anchored to the wall.

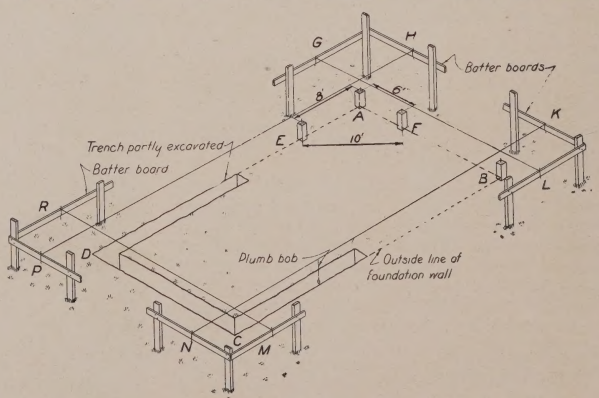
When frames are set after the wall is built, rough "bucks" must be set in the forms to provide the required openings. Nailing blocks are lightly tacked to the backs of the bucks. When concrete has hardened the bucks are removed, leaving the nailing blocks firmly imbedded in the concrete with one surface exposed. The frames are then set and nailed to the blocks. The first method is much the simpler and insures the tighter joint, and is, therefore, most generally used.

Laying Out the Foundation The easiest, quickest and most accurate way to determine the boundary lines of a new building is by means of surveying instruments. When such instruments are not available, one of the simplest methods for laying out corners, known as the right triangle method, can be used. A triangle with sides 6, 8 and 10 feet long is a right triangle and the 90 degree angle, or right angle, is opposite the longest side.

First, a base line is established, marking out one end or side of the new building. See line A-B on this page. Stakes are set at A and B on this line, locating two corners.

In the top of Stake A a nail is partly driven in near the center. This nail accurately locates the corner. On the line A-B another stake is driven at F, 6 feet from Stake A. A nail is driven in the top of this stake exactly 6 feet from the nail in Stake A. Stake E should be driven so that its center will be exactly 8 feet from Stake A and exactly 10 feet from Stake F. The corner represented by the angle E-A-F is a right angle; the line A-E extended to D will form the second boundary line of the building and D will represent the third corner. Other corners are located in a similar manner.

After the corners have been accurately located, strings are stretched over the corner Stakes A-B-C-D and carried to outside supports called "batter boards" as indicated by G-H-K-L-M-N-P-R. The top of the horizontal batters should be set at first floor level or some other convenient height. The building lines may be projected



Method of squaring up corners and of using batter boards to establish building and excavation lines for foundation trench.

from the strings to the ground by means of a plumb bob suspended as shown in the drawing. When the outside Stakes G-H-K-L, etc., have been set and the strings indicating the layout of the building transferred to them, the corner Stakes A-B-C-D and Stakes E and F are removed so that the trench may be excavated. Nails should be driven in the batters where the strings are fastened so that in case the strings are broken or removed they can be accurately replaced. Having found the building lines, it is easy to locate piers, posts, columns or other intermediate supports.

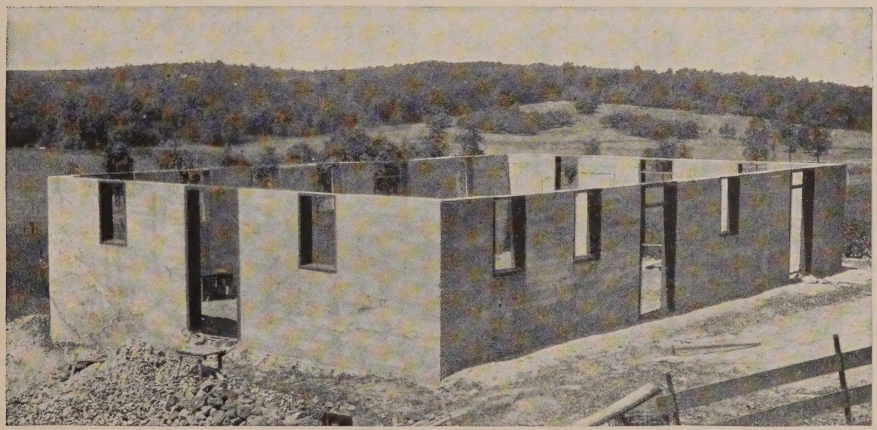
Post and Pier Footings

Footings for the posts which support the inner structure of a building are as essential and important as are the footings which support the foundation wall. Concrete is the ideal material for use in the construction of these footings, for when deposited in thin layers and well rammed it becomes firmly imbedded in the depressions caused by digging the footing location and reduces the possibility of settling to the actual compression of the soil.

Settlement due to compression of the soil may be eliminated by designing the footing to conform with the safe soil loads given in the table on page 38. For light one-story buildings the footing should be 12 inches wider, that is, 6 inches on each side, than the thickness of the post. In residence construction where even the slightest settling will cause unsightly plaster cracks and squeaky floors it is considered advisable to use a footing 24 inches wider than the post. This width will decrease the unit pressure on the soil and minimize the danger of settling.

Single concrete block should not be used for post footing on account of the relatively small bearing area. The economical and efficient footing is one which has been correctly designed and constructed of monolithic concrete.

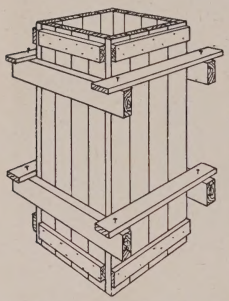
Laying up a concrete masonry wall.



First story walls of monolithic concrete have been completed. Bolts have been set in the top of the walls for attachment of sills for the superstructure.

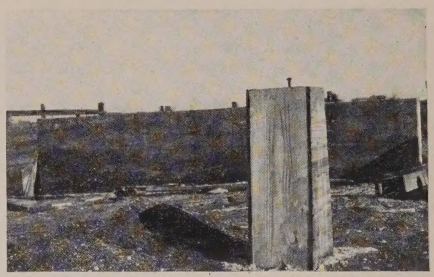
Concrete Piers

Light wooden sheds, barns and frame houses without cellars should be supported on concrete piers or posts. Such piers are rot-proof, fireproof, easy to build and will not require replacing. A simple form for a rectangular pier is shown on this page. Footings for piers should have sufficient spread or bearing area so that they will carry the load without settlement. The proper mixture for pier construction is given in Table I, page 4.



A simple form for constructing concrete piers. It is built in four sections and is quickly set up and taken down.

Piers are often built of concrete masonry. Many manufacturers of concrete products make pier block of various sizes to support porches, small houses and other light frame structures. If the base of the pier does not have sufficient area to transmit the load to the soil without settlement, a monolithic concrete footing should be placed under the pier. For laying pier block, a mortar mixed in the proportion of 1 part portland cement to 1 part hydrated or well slaked lime to 6 parts sand (measured by volume) is recommended. Block should be carefully imbedded in the mortar so that the mortar bed will develop strength equal to that of the units, thus eliminating the possibility of weak joints.



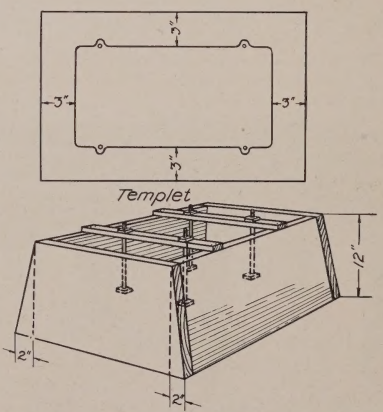
Constructing a concrete pier for a cattle shed.

Machine Foundations

Concrete is ideal for making foundations for gas engines, cream separators and other stationary machinery. The depth to which foundations should extend will depend on the weight of the machine and the load bearing power of the soil. The length and width of the top of the foundation will be governed by the dimensions of the machine base—a margin of 2 or 3 inches should be allowed on all edges when possible. If the machine requires greater stability in one direction than in the other the base might be lengthened accordingly.

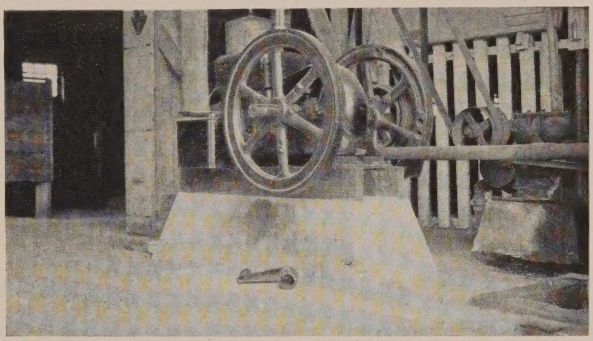
A method of constructing forms for machine foundations is shown in an accompanying illustration. Such a foundation should always be placed first and the floor laid around it afterwards. In the event the floor is already in, it is advisable to cut out a section where the machine foundation is to be located. Except for light machinery the foundation should never be placed directly on a concrete floor.

Anchor bolts for the attachment of machinery are imbedded in concrete, using a templet as shown, to make sure that bolts are correctly spaced. For ease in adjustment a pipe sleeve larger than the bolt can be slipped over it, and filled with cement mortar after the machine is



Forms for gas engine base and templet for proper placement of anchor bolts.

lined up and before it is finally bolted down. This templet is taken off after the concrete has hardened sufficiently to grip the bolts and the surface is then levelled off. At this point it is well to check all measurements. The mixture recommended for this class of work (see Table I, page 4) is 6 gallons of water for each one-sack batch of portland cement when damp aggregates are used. Trial proportions are 1 sack of portland cement, 3 cubic feet of sand and 5 cubic feet of pebbles or crushed rock.



Concrete foundations provide rigid durable bases for gasoline engines and other stationary farm machinery.

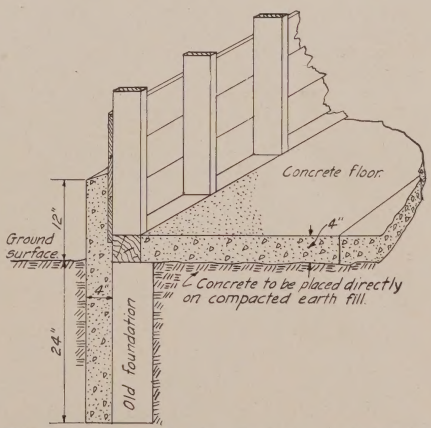
Rat-Proofing Buildings

The destruction wrought by rats in the United States amounts to $200,000,000 annually. Such unnecessary waste, coupled with the repugnance of housing rats and eating stored food in common with them demands that steps be taken for their eradication. This is best done by building them out. Rats, while burrowing animals themselves, seldom burrow in open fields on account of their natural enemies. Instead they seek shelter beneath buildings, in and around rubbish piles, in sewers and drains, and similar places where they can have runways and where they will not be molested.

Trapping and poisoning is inadequate as a means of exterminating rats. Reduction in the number of rats is temporary in character at best. The use of viruses, a method whereby rats become infected with disease producing bacteria, and thus causing death is open to many objections.

Food and grain should be stored in rat-proof receptacles or in rat-proof buildings. In this, and only in this way is it possible to eliminate the rat nuisance. It is obvious that if rats are furnished good homes and plenty of food, they will breed, and attempts to reduce their number will be futile.

The cost of rat-proofing is small compared with the saving effected, and often the details of construction in a new building can be so arranged as to include thorough rat-proofing at no additional expense. In old buildings usually only minor changes of a simple nature are involved to make them rat-proof. The policy of rat-proofing should be consistent; all the buildings of a group must have incorporated in them the essential elements of practical rat-proofing, if the greatest benefits are to be realized from it.



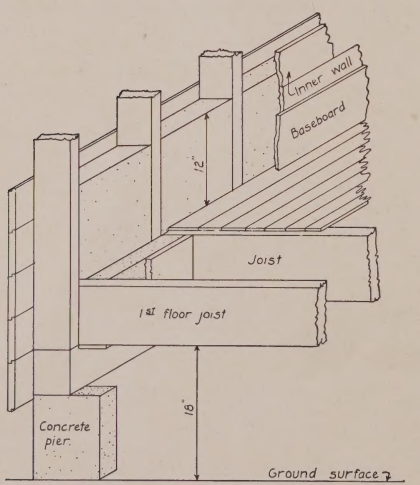
Old buildings where food and feed are kept are made ratproof by constructing a concrete wall on the outside or inside of the old foundation. Concrete floors should be placed directly on an earth or cinder fill.

Concrete used in foundations, walls and floors is effective in the exclusion of vermin. It is equally well adapted for this purpose in both new and old buildings. Rat proofing of new construction can well be accomplished by following these suggestions:

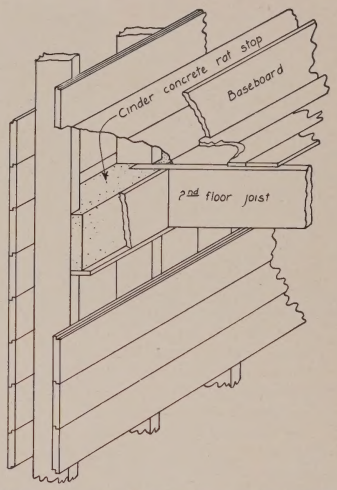
1. Make continuous concrete foundations extend at least to a point below burrowing depth—about 24 inches; for buildings with a basement, the foundation walls will usually extend considerably deeper than this.

2. Let the concrete extend at least 12 inches above the ground line to discourage the gnawing which is common at this place.

3. When posts or piers are used as supports, make these high enough to raise the building at least 18 inches off the ground if the building is 30 feet wide or less, increasing this height 6 inches for each additional 10 feet in width. This discourages rats from using the space beneath the floor as a shelter. If the space between the piers is walled up, windows or screened openings as large as practical should be provided to admit light to the enclosure from at least three sides. The space between the floor joists should be completely closed at the wall with 2-inch plank wide enough to lap over the lower edge of the sill, and the boxed space thus prepared filled with concrete.



When buildings are supported on posts or piers they are made ratproof by raising them 18 inches or more above ground level and by placing concrete between inner and outer walls above sill.



Second and upper story floors are made ratproof by filling in between joists with concrete.

4. Use concrete floors wherever possible. These may be laid directly upon well-drained, well-packed soil, or upon a base of compacted cinders, gravel or stone.

5. All necessary openings should be protected with ¼-inch mesh, 12-gauge wire screen. Doors should be provided with spring hinges to insure their automatic closing. Leave no doors, windows, or other openings unprotected.

Old buildings present different problems, but their solution is not difficult. The following points should be emphasized:

1. The new wall should be carried down at least 2 feet below the surface of the ground to prevent rats burrowing underneath.

2. Locate a new continuous 4-inch concrete foundation wall alongside the old wall, either outside or inside, as most convenient.

3. Replace old wood floors with new ones of concrete.

4. Pack concrete in the space between joists and studs, at each floor level.

5. Screen all openings as recommended for new construction.

CHAPTER V

Troughs and Tanks

THE main requirement for water tanks and troughs is, of course, that they be watertight—a requirement that is very satisfactorily met at a reasonable cost by using concrete. There is no danger of decay or collapse of a concrete tank or trough and no material is more sanitary.

One of the simplest and perhaps most useful troughs for the beginner to attempt as his first work of this kind is shown in an accompanying sketch. Such a trough can be cast upside down, either on an even, level barn floor or a platform provided especially for the purpose as shown in the drawing. The center sketch gives a general view of the forms and the platform on which they are supported, while to the right of the group is shown the appearance of the trough after the forms have been removed, except that a portion has been cut away to show the reinforcing.

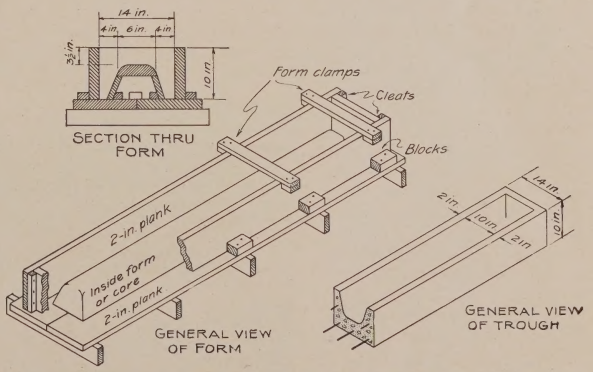
Forms should preferably be made of 2-inch material. All surfaces coming in contact with the concrete mixture should be oiled or greased to prevent sticking when the forms are removed. A set of forms like those shown may be used again and again. The surfaces, however, should be cleaned and reoiled before each filling.

For making concrete troughs the first trial batch is made of a mixture containing 1 part cement, 2 parts sand and 3 parts pebbles (See Table I, page 4). If sand and pebbles are in a moist condition, the correct amount of water to add to each one-sack batch is 4¼ gallons. It may be necessary to vary the proportions of sand and pebbles slightly as explained on pages 4 and 5. As the sides of this trough are only 2 inches thick at the top, the largest size pebbles used in the concrete mixture should not exceed ¾ inch in diameter.

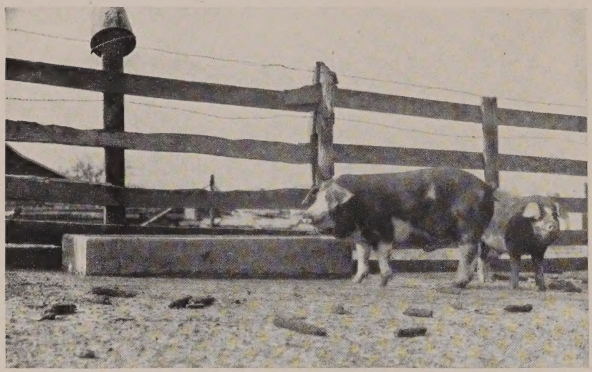
All troughs and tanks should be reinforced either with steel rods or wire mesh. Usually, ¼ to ⅜-inch steel rods are used. For a small trough ¼-inch rods are satisfactory, when placed as shown in the drawing.

Watering Tanks The illustrations on page 47 present plans for a rectangular stock watering tank. Forms for either a rectangular or circular tank may be homemade, but if commercial silo forms are available they may be used to advantage if a circular trough or tank is to be built.

The following details of construction should be observed. Immediately after setting up the outside forms, concrete is deposited to one-half the thickness of the floor. Reinforcing rods are then placed in position as shown in the illustration. The reinforcing consists of ¼-inch round rods, bent to a "U" shape. When bent in this manner, the rods not only reinforce the tank floor, but extend up into the walls, forming part of the reinforcement (vertical) required for the sides and ends. Reinforcing may be assembled before setting it in place, the "U"-shaped rods being wired together at intersections so as to form a sort of a cage or basket. Horizontal reinforcing extending entirely around the walls is also wired in place.



Forms for small concrete trough. Also the finished trough with one end cut away to show reinforcement.



Concrete troughs never dry out and are heavy enough so that hogs cannot overturn them.

After the network of reinforcement has been set in the proper position, concrete is deposited to complete the thickness of the tank floor. The inside form, which should always be built before concreting is started, is then set in position and secured by means of boards extending across the forms. Concrete for side walls is placed immediately so that there will be no construction joints where the tank walls and floor join.

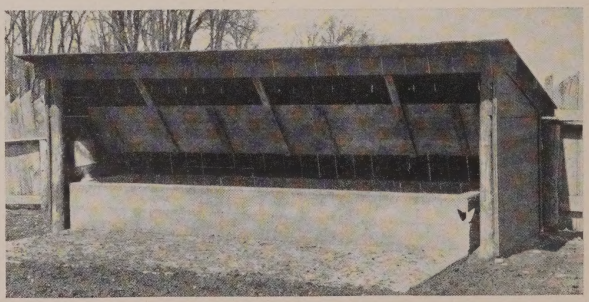
Concrete should be thoroughly spaded next to the forms to force all large particles of aggregate back from the surface. This will insure a dense and even surface. The inside face of the tank walls is battered, that is, sloped outward toward the top for the purpose of relieving pressure on the tank walls in case ice forms.

After the concrete has hardened sufficiently to be self-sustaining, forms may be removed. It is advisable at this time to give the interior a cement wash to insure a smooth surface. Any rough spots should be filled with a 1 part cement to 2 parts sand mortar. The concrete should be protected from drying out for a week or 10 days, after which time the tank may be put in use. Inlet and outlet pipes should be set while concreting is in progress.

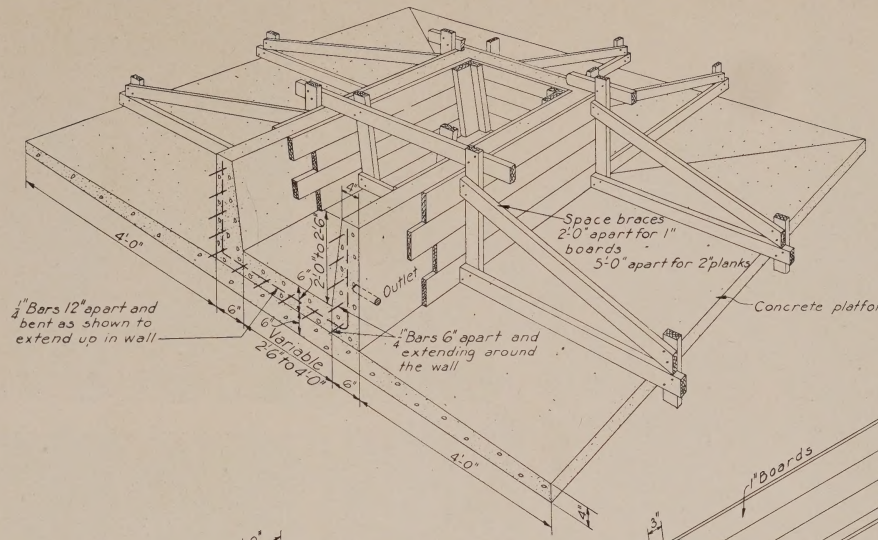
It is always desirable to build a concrete pavement 6 inches thick around the tank. This will prevent the stock from forming a mudhole and will insure a dry place for them to stand while drinking. This pavement is constructed like a sidewalk or barnyard pavement, and may be laid after the tank is completed, except when the platform is made large enough to support the tank and provide standing room on all sides. In that event the pavement is constructed first, at least that part of it upon which the tank is to stand.

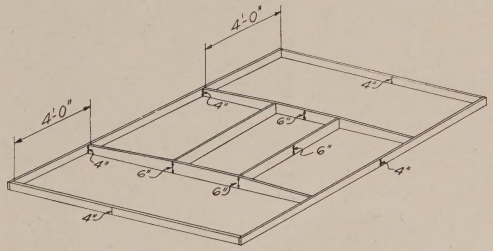
Materials Required for a Rectangular Tank Outside dimensions, 3 ft. 6 in. by 8 ft.; Walls, 2 ft. 6 in. high; Floor, 6 inches thick; Estimates based on a 1:2:3 concrete mixture: 10½ sacks portland cement; 1 cubic yard of sand; 1½ cubic yards of pebbles; 240 feet of ¼-inch steel rods. The tank base 11 feet 6 inches by 16 feet requires 24 sacks of cement, 1¾ cubic yards of sand and 2⅔ cubic yards of pebbles.

Repairing Leaky Tanks Improper mixtures or incorrect construction methods may result in porous spots in the construction of concrete tanks through which the contents will leak. Such tanks may be repaired by giving the whole interior of the tank a cement plaster coat. Preparatory to applying this plaster coat, the surface to be treated should be thoroughly cleaned by scrubbing with a good stiff brush and water, or better still, washed with a solution of 1 part of commercial muriatic acid to 3 or 4 parts of water, allow-

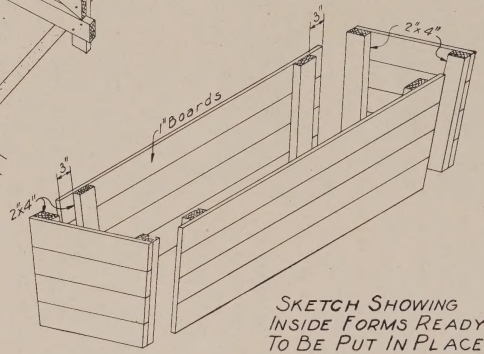


A sanitary concrete stock watering tank stays watertight.


4'-0"
6" to 26"
Outlet
Space braces 2'-0" apart for 1" boards 5'-0" apart for 2" planks
Concrete platform
1/4" Bars 12" apart and bent as shown to extend up in wall
6" Variable 26" to 4'-0"
6"
1/4" Bars 6" apart and extending around the wall
4'-0"
4"



SKETCH SHOWING ARRANGEMENT OF FORMS FOR TANK BASE

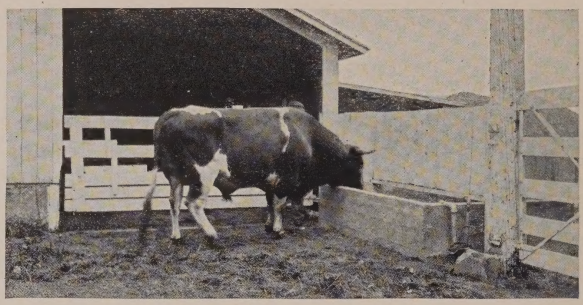


SKETCH SHOWING INSIDE FORMS READY TO BE PUT IN PLACE

Forms for building stock watering tank. Also forms for constructing concrete base and drinking platform.

ing this to remain for a few moments and then thoroughly rinsing off the surface with clean water. The acid treatment removes the cement coating from the particles of sand and gravel, thus exposing clean surfaces to which the cement plaster will more readily adhere.

The cleaned surface should be painted with a wash of cement and water mixed to the consistency of cream and applied with an ordinary whitewash brush just in advance of the plastering. Before this has commenced to harden, plastering mortar mixed in the proportions of one part cement to one and one-half or two parts of sand should be applied at once. Mortar can be applied with a steel trowel, after which the surface should be worked thoroughly, and as soon as possible, with a wood float to make a dense, impervious coating. Final smoothing may be done with a steel trowel, but over-trowelling should be avoided. The surface of the plastering should be covered with burlap or canvas an hour or two after it has begun to harden and kept wet for several days so that the plaster coating will harden thoroughly and uniformly.

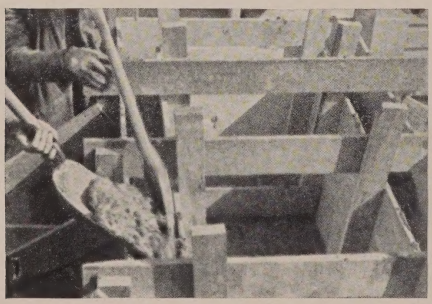


A durable, easily made stock watering tank.

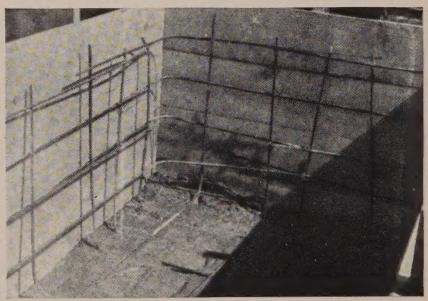
Milk-Cooling Tanks

Well constructed milk-cooling tanks are saving dairymen of this country thousands of dollars annually by providing suitable places for cooling and holding milk until time for marketing. Without proper cooling facilities, milk soon sours, causing heavy loss to the producer. In many localities the value of clean uncontaminated milk has been so generally recognized that health authorities have required that dairymen build concrete milk houses and cooling tanks.

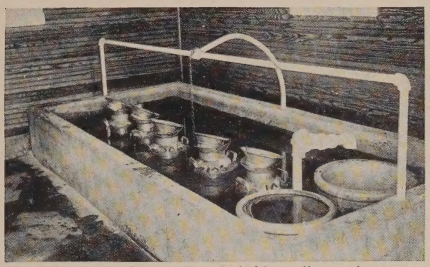
A milk-cooling tank is very similar in construction to a watering tank; form construction is alike; the same mixture of concrete is used in both, and the same principles of reinforcing are employed. Reinforced concrete milk-cooling tanks may be made either with or without insulation; the insulated tank being recommended when milk is cooled with iced water or by mechanical refrigeration. Suggested plans, including construction details, for both types are



Concrete is thoroughly spaded as it is placed in the tank forms.



Reinforcement is wired together forming a cage or basket.



A concrete tank where milk is cooled by well or spring water.

presented herewith. Corkboard is used in the insulated tank shown although any other suitable insulating material may be employed in place of the cork, if desired.

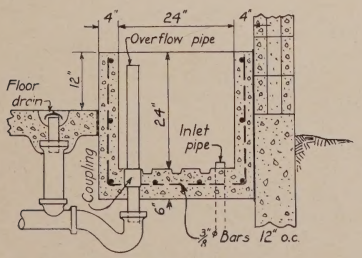
When milk is cooled by well or spring water, a minimum net width of 24 inches is recommended for the tank, but in case either iced water or mechanical refrigeration is used, this width may be reduced to 19 inches. The tank is made only deep enough to permit water to come well up on the necks of the cans. To lighten the labor of lifting the cans in and out of the tank, part of its depth is below the floor level. The length is variable, depending upon the capacity desired.

Concrete Tank Without Insulation

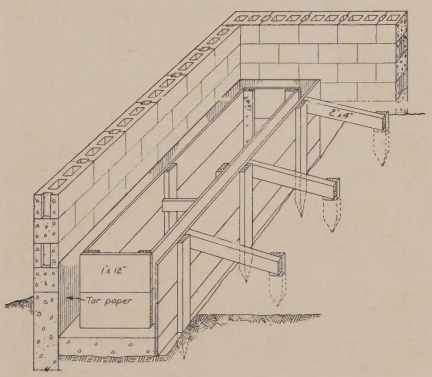
If ice is not available, milk usually can be cooled to 55 degrees Fahrenheit or lower by circulating spring or well water through the tank. A uniform flow of water is secured by placing the inlet pipe at one end of the tank and the outlet or overflow pipe at the opposite end. The overflow pipe screws into the outlet drain and is equal in length to the depth of the water desired. The grooves in the tank floor permit water to circulate freely under the cans, resulting in more rapid cooling of the milk. These grooves are made by pressing beveled wood strips into the concrete at the time the floor is finished. Before the concrete has hardened the strips are removed. Inlet and outlet fixtures must be set in position before concreting is started.

When the solid wall or uninsulated tank is built, the floor and walls are concreted in one operation. The floor of the tank is made 6 inches thick and the walls, 4 inches. Reinforcing consists of ⅜-inch rods spaced 12 inches apart. The reinforcement of the floor and walls is made continuous by bending the rods "U" shaped. Rods are also extended around the tank walls, with ends lapped at least 12 inches. At all intersections reinforcing rods are firmly wired together to hold them in correct position.

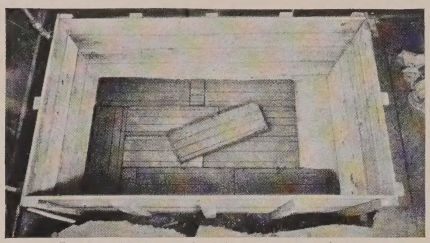
As in water tank construction, concrete for one-half the thickness of the floor is deposited and then the reinforcing network is set in place. The inside form which has been previously constructed is put into position, after which concrete for the top 3 inches of floor is deposited and then the walls are concreted. Where it is desired to utilize outer walls of milk houses for tank forms, a double thickness of waterproof building paper should be placed against the outer walls so that the tank and walls will remain separated. Tongued and grooved lumber dressed on one side is best for forms although any material that will fit together tightly may be used. Bracing and nailing should always be done with a view to render the removal of the forms easy and with-



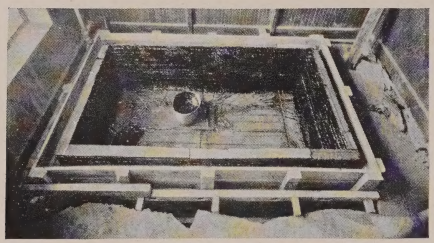
Cross-section of milk-cooling tank without insulation in walls.



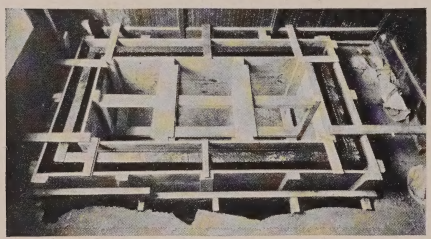
Forms for building uninsulated milk-cooling tank.



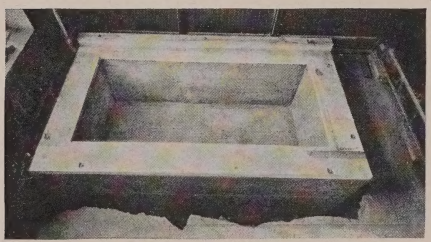
Exterior forms in place for an insulated tank.



Insulating cork board is mopped with tar and set so as to provide a space of 3 inches between it and exterior form.



Both inner and outer forms in place, ready for placing concrete. Concrete mixture should be kept about level on both sides of insulating material so as not to displace it.



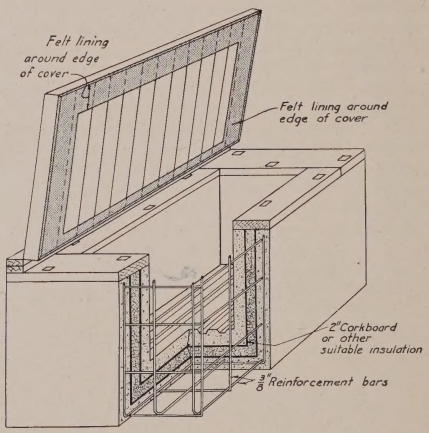
The completed tank. Cover is attached to tank by means of bolts set in the concrete.

out damage. Beveling the ends of the boards slightly will aid in their removal.

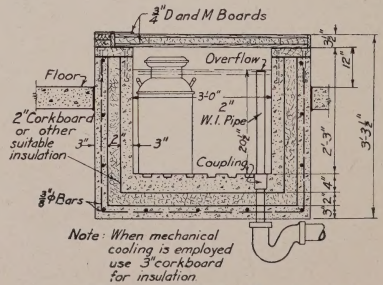
Insulated Milk Cooling Tank

Below are presented details of an insulated milk-cooling tank. Reinforcement for this tank is practically the same as for the tank without insulation. Rods are placed only in the outer walls. The reinforced concrete base below the corkboard should be not less than 3 inches thick and is constructed in the same manner as the base for the uninsulated tank, with the reinforcement in the center of the 3-inch layer.

Two-inch corkboard mopped on both sides with hot asphalt is then laid on the concrete


Felt lining around edge of cover
Felt lining around edge of cover
2" Corkboard or other suitable insulation
3/8" Reinforcement bars

Perspective view of insulated milk-cooling tank with section cut out to show location of reinforcement and insulating material.



Cross-section of an insulated milk-cooling tank.

base. The corkboard for walls is dipped or painted with hot asphalt at the same time. Coal tar pitch may be used if asphalt is not available.

Forms for both the outside and inside walls of the tank are placed next and 2-inch corkboard for wall insulation is erected, making certain that all abutting edges between sections are thoroughly covered with asphalt. Corkboard must be braced to prevent displacement. Outside and inside walls are made the same thickness as the lower base of the tank—3 inches. The concrete base of the inner tank is placed next, making it 4 inches thick as shown. Forms are then filled with concrete of a consistency that will place readily with light spading.

In depositing concrete for walls, keep both walls at about the same level in order to prevent displacement of corkboard. One-half-inch bolts to which a wooden plate or rail around the top of the tank is to be attached are set in proper place in top of the walls with about 1½ inches of the threaded end protruding.

When it is desired to install mechanical refrigeration, an opening for the coil may be made in the wooden rail or in the concrete wall of the tank, according to manufacturer's directions. If it is decided to build the tank so that mechanical refrigeration may be employed at some future date, it would be well to provide an opening for installation of the coil. This hole may be filled with a wooden plug until the cooling apparatus is installed. Three-inch corkboard insulation is usually recommended when the tank is built for mechanical refrigeration.

After the concrete in the tank walls has hardened the plate may be bolted on, the nuts being counter sunk to permit tight closing of the cover. The wood cover should be of rigid construction to prevent warping, and carefully made and attached to insure a snug fit. Framework of 2-inch material is covered with dressed and matched boards between which a 2-inch thickness of corkboard is placed. The cover is fastened in place with large galvanized Tee hinges and should be painted on all sides and edges.

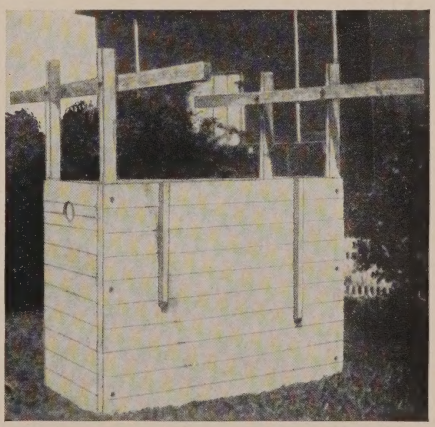
Concrete Mixtures For both types of tanks, the recommended proportion is 4¼ gallons of water for a one-sack batch together with such amounts of moist sand and pebbles as will produce a workable, plastic mixture. (See Table I, page 4.) Forms are removed as soon as concrete has hardened sufficiently and any rough spots are filled with a 1:2 mortar and the interior is given a cement wash finish.

Concrete Septic Tanks

The development of the septic tank is a great boon to those who live where sewers are not available for it provides a safe method of disposing of the wastes from the modern bathroom and the kitchen sink. It is endorsed by health authorities and thousands of installations testify to its successful use.

A septic tank is a watertight concrete receptacle in which the solid particles in sewage are broken up by bacterial action. Part of the solids are converted into gases and liquids while a small portion called sludge sinks to the bottom. With the septic tank in operation a scum or mat forms on the surface and the tank is so designed with baffle boards and special inlets and outlets that incoming sewage will cause the least possible disturbance of the sewage already in the tank. The contents of the tank must remain quiet if the best results are to be obtained.

It is important that a septic tank have sufficient capacity to insure reasonably complete dissolution of the solid matter. In designing a sep-



Forms for single chamber septic tank.

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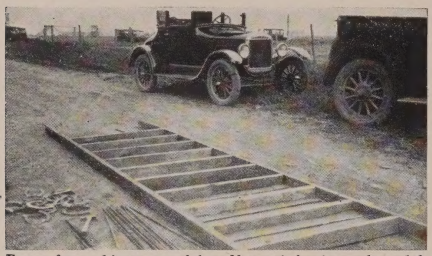


Forms for making cover slabs. Note reinforcing rods on left of forms.

tic tank, it is common practice to make it large enough to hold a minimum of 50 gallons for every person served. That is, for a family of nine persons, a tank holding at least 450 gallons is required. Some authorities prefer tanks holding 60 or 70 gallons per person. It is seldom advisable to build tanks holding less than 450 gallons even though serving but two or three persons. The additional capacity will enable the tank to function properly at times of heavy flow and will render the tank satisfactory in case it becomes necessary to serve a larger number of persons at some later time.

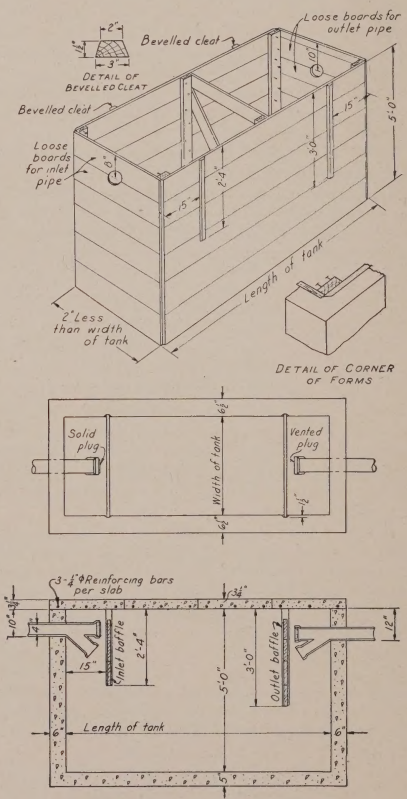
SIZES OF SEPTIC TANKS

No. Persons Served	Inside Dimensions in Feet			Gallons Capacity
	Length	Width	Depth	
7 or less	6	3	5	540
10	7	3	5	630
14	8	3	5	720
21	9	4	5	1,080
24	10	4	5	1,200

The liquid called the effluent, flowing out of a septic tank is far from being pure and is given further treatment in what is known as a purification field. This consists of one or more lines of ordinary farm drain tile laid with open joints into which sewage is discharged and allowed to seep out into top soil where bacteria of another sort complete the purification. These tile are laid near the surface, usually 12 to 18 inches deep, and to a slight pitch, ½ inch in 10 feet, to insure drainage.

The length of the drain tile in the absorption or purification field depends upon the quantity of sewage to be handled as well as upon the character of the soil. Where there is a light porous soil and the ground-water level is several feet below the surface, 30 feet of tile for each person served may be enough. In tight clayey soils as

Placing concrete cover slabs. Reinforcing rods are located one inch from bottom of slabs. Horseshoes are set in concrete to provide convenient handholds for moving slabs.

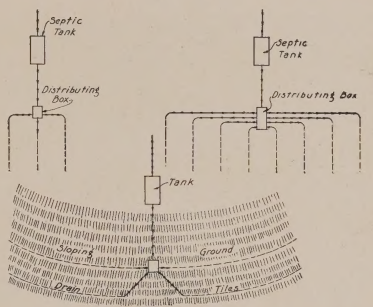


Plans for single chamber septic tank.

much as 100 feet of tile per person may be required. It is well to locate lines so that they may be extended or branch lines can be added if necessary to insure good results.

If sewage appears on the ground above tile lines, it is an indication that the distributing system is too small and should be enlarged.

The sewer line connecting the plumbing system in the house with the septic tank should consist of bell-mouth sewer tile with tightly cemented joints to prevent leakage. These should be laid with a uniform slope of between $\frac{1}{8}$ and $\frac{1}{4}$ inch per foot. It is good practice to use a few lengths of bell-mouth sewer tile with cemented joints at the septic tank outlet. Tile carrying sewage should never be laid with open joints in the vicinity of a well or other source of water supply.



Final purification is completed in the absorption field, in which there are lines of drain tile laid 12 to 18 inches below the surface of the ground.

Building the Septic Tank After deciding upon the proper size tank to build and selecting its location, excavation is made. If the soil is of the type that does not cave in readily, it is a usual practice to use the earthen walls of the pit for the outside forms. In this case the excavation should be made to the exact dimensions of the outside measurements of the tank, care being taken to make the sides of the pit smooth and vertical and the corners square. If the banks of the excavation cave, both outer and inner forms will be required. In this case the excavation should be somewhat longer and wider to permit placing and removing exterior forms.

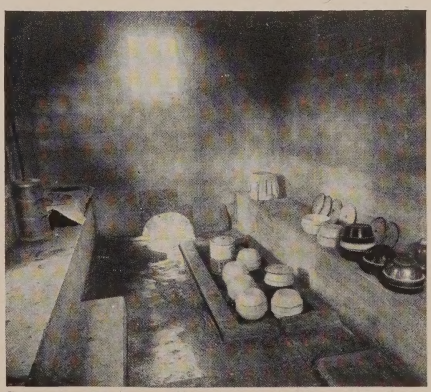
Since it is desirable that the septic tank be watertight, the correct amount of mixing water to add to a one-sack batch mix is $4\frac{1}{4}$ gallons when sand and pebbles are in a damp condition. See Table I, page 4, and read carefully instructions on making concrete, pages 3, to 14.

Concrete Spring and Well Curbs and Platforms

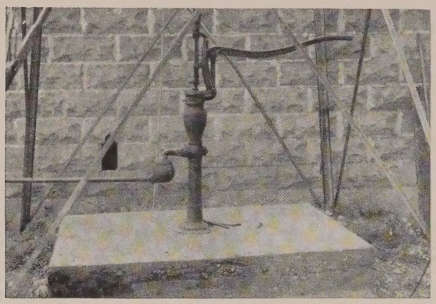
Concrete curbs and platforms are recommended by health authorities as a means of protecting spring and well water supplies against pollution. The permanent nature of concrete makes it particularly suitable for this class of work. Once built, concrete curbs and platforms last indefinitely.

Both springs and wells are protected by extending concrete curbs high enough above the ground to prevent contaminating surface water from entering, and deep enough to exclude polluted seepage and burrowing animals. Complete protection is secured by covering the water supply with a concrete platform.

Construction For outer forms the earth wall is generally sufficient, but if not, forms will have to be made and the excavation enlarged enough to provide room for them. A convenient collapsible interior form is shown in the drawing; it is made in four sections,



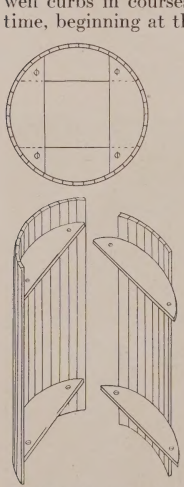
Concrete spring house. Water is protected from pollution by concrete walled enclosure.



Concrete well curb and platform protects water supply against surface contamination.

the crosspieces being held together by bolts which can be removed when the form is taken down. One-inch material is suitable for forms. The sheathing boards should preferably be not more than 4 inches wide. A coating of oil applied to the forms will prevent concrete from sticking to them. For small wells, a curb thickness of 4 inches is sufficient but for large wells 6 inches is recommended. Inner and outer forms should be made of such dimensions that the desired wall thickness will be obtained.

It may be found advantageous to construct well curbs in courses, building 3 or 4 feet at a time, beginning at the lowest level and working upward. Usually concrete is allowed to harden 24 hours before forms are removed and reset for the next course.



Easily built forms for constructing circular well curb.

A concrete platform is almost indispensable. For wells and spring enclosures of a diameter of 6 feet or less, a platform 4 inches thick at the edges is adequate, if it be reinforced with ¼-inch or ⅜-inch rods spaced 6 inches apart in both directions, the rods being placed about 1 inch above the lower surface of the concrete. If reinforcing rods are not obtainable, wire mesh may be used instead. The platform should extend well over the edges of the curb and should be at least an inch higher in the center than the edges to insure good drainage.

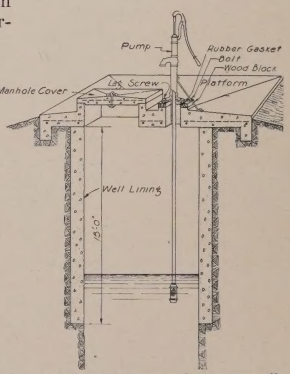
The bottom form for the cover slab is made by building a tight board platform, which can be braced in position from below or suspended by wire or brackets to the previously placed curb. Before placing the concrete, provision should be made for a manhole in the cover and also an opening for the pump stock. Bolts are often set in the concrete for attachment of the pump base. A simple expedient for providing a manhole is to set a large dishpan on the platform form. Removal of the pan will leave an opening with sloping edges in the concrete, for which a close-fitting concrete cover can be made by casting it in the interior of the pan. The cover slab forms can be dismantled and removed through the manhole. Do not remove the platform forms too soon; in warm weather allow a week and in cool weather an even longer time.

Mixtures For the platform and for the upper part of the curb, a watertight concrete is recommended. This is secured with a mixture containing not more than 4¼ gallons of water for each one-sack batch when damp sand and pebbles are used. See Table I, page 4 and read carefully instructions on pages 4 and 5.

If the curb is carried to the bottom of the well, the lower sections should have openings to permit water to pass through the walls. These are made by laying greased plugs in the wall as concrete is deposited. When forms are removed the plugs are withdrawn.

As the concrete mixture is deposited in the forms, it should be tamped and spaded and any rough spots found on removal of the forms may be patched with 1:2 cement mortar. The platforms hould be finished with a wood float to secure a smooth yet somewhat gritty non-slippery surface.

The drawing presented here illustrates one of the latest and most popular types of concrete well curb and platform construction.



Drawing showing details of concrete well curb and platform construction.

CHAPTER VI

CONCRETE POSTS

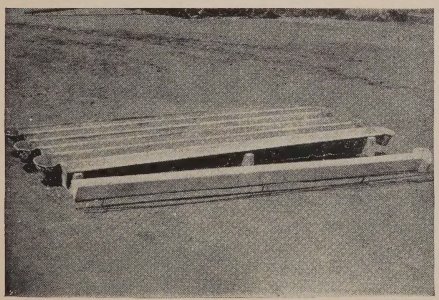
CONCRETE fence posts are becoming increasingly popular due to their many superior qualities. They will not rot nor are they injured by borers or fungus growths. Their uniformity in size and shape makes them easy to set and line up. A fence with concrete posts presents an attractive appearance and greatly enhances the value of the property on which it is located.

When concrete posts are used, weeds and trash that accumulate along the strip of land occupied by the fence can be burned off without injury to the posts. Countless weed seed can be destroyed in this way as well as millions of eggs of insect pests.

Concrete posts make ideal supports for grapevines. They are permanent and will outlast the vineyard. Once set, they require no replacement, consequently vines and roots are not disturbed. Grapevine posts are made in exactly the same manner as concrete fence posts.

Dimensions and Shapes of Concrete Posts

Concrete posts can be made in a variety of different shapes. When home-made molds or forms are used, concrete posts having a rectangular cross-section will generally be found the easiest to make. Posts having triangular, round, half-round or "T"-shaped sections are usually made in metal molds.



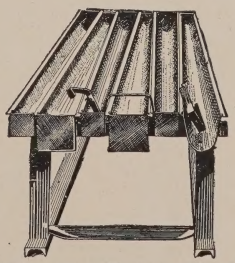
Commercial molds of metal may be used indefinitely. They produce posts of very attractive appearance.

Concrete fence posts will not rot nor burn. Their neat appearance helps make the farm look trim.

The usual length of line posts is from 7 to 8 feet. A strong, neat appearing homemade post will be obtained by making the base 4 by 5 inches, tapering to 4 by 3 inches at the top; then 2 by 4's can be used for the pallets.

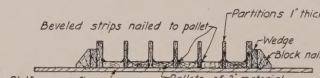
Molds

Satisfactory results can be obtained by using homemade wooden molds. Several simple gang molds have been devised; one good type is shown in the drawing on page 56. If a level floor is available, it will not be necessary to build a platform. Lumber used in constructing molds should be sound, straight-grained, and finished smooth on the sides that will come in contact with the concrete. Two-inch material is used for the sides and end-pieces and 1-inch boards for the dividers. Small triangular strips are tacked to the pallets which give the post a neat and finished appearance on two edges. The forms should be soaked or painted

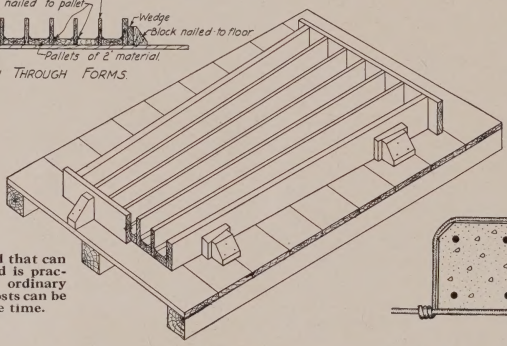


A commercial fence post mold which produces posts with a D-shaped section.

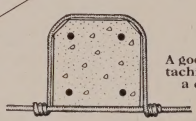
Practical shapes for concrete posts are shown in cross-section. Dots indicate correct placing of reinforcing rods.

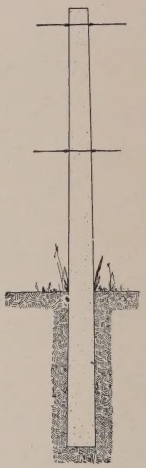


SECTION THROUGH FORMS.

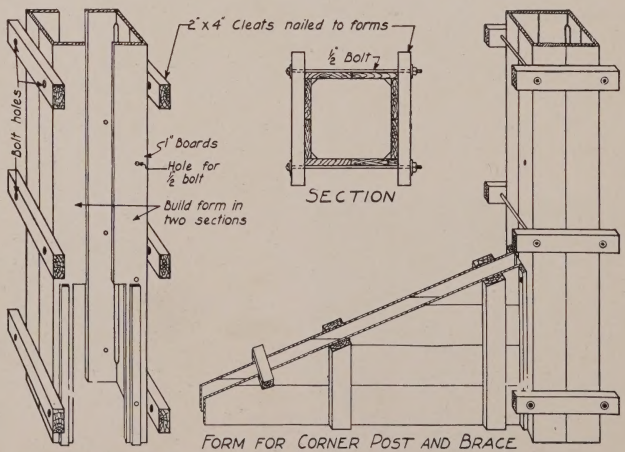


A homemade mold that can be easily built and is practical for making ordinary fence posts. Six posts can be produced at one time.





A good method of attaching fence wire to a concrete post.



Simple method of making forms for corner posts and brace.

Concrete has solved the troublesome post problem in vineyards.

with oil to prevent the boards from warping and the concrete from sticking to them.

Posts made in metal molds ordinarily are more true to shape and have a smoother surface than posts cast in homemade wooden molds. Whenever a number of posts are to be made the use of commercial molds will be found advisable.

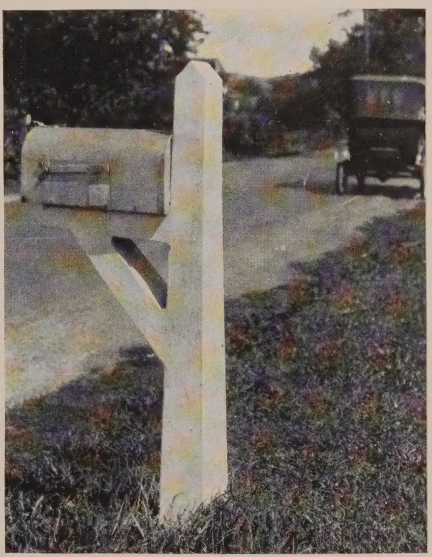
Reinforcement Reinforcing a concrete post deserves special attention. The black spots shown in the drawing of cross-sections on page 56 represent the proper location of reinforcing rods. The rods are located near each corner where the greatest tensile stresses occur and ¾ inch from the surface in order that moisture will not penetrate to them and cause the steel to rust. Reinforcement placed nearer the center of the post becomes less effective, while if placed nearer than ¾ inch to the surface, it is likely to rust, possibly causing the concrete to spall off and the post to fail. One-quarter-inch round or square rods have proved to be most satisfactory for reinforcing concrete posts.

Concreting Table I on page 4 shows the proper mixture of concrete for fence posts. The thoroughly mixed concrete is first placed about 1 inch deep in the mold, then two reinforcing rods are pressed into the concrete, one in each corner, ¾ inch from the side and bottom. The mold is next filled with concrete to within ¾ inch from the top and the other two reinforcing rods carefully imbedded in it. The mold is then filled to the top, struck off and troweled. As concrete is placed, it should be compacted by jarring or tapping the mold and by running the trowel along the form faces and up and down in the concrete. Care must be exercised not to displace the reinforcement. This operation works coarse particles back from the surface, removes air bubbles, produces a dense concrete and gives the post a smooth surface.

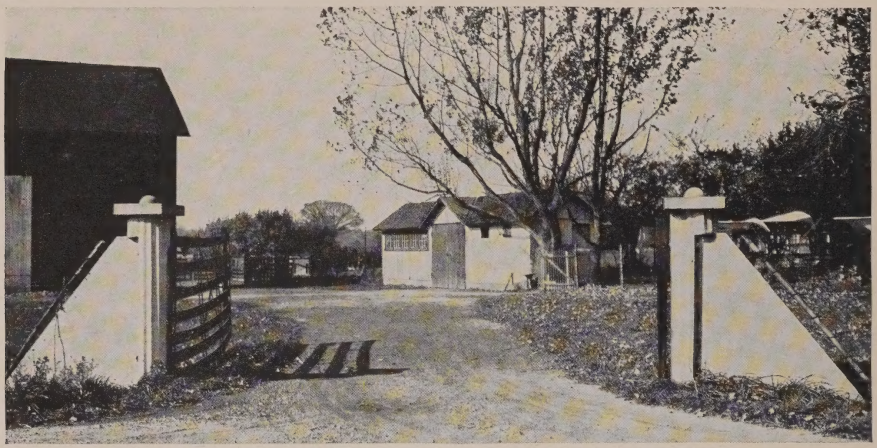
Taking Posts Out of Mold After the molds have been filled, they should remain undisturbed until the concrete has hardened sufficiently to permit removing the posts without damage. In summer, 24 hours may be sufficient but in cold weather more time will be required. Be careful not to crack posts when removing them.

If made in summer, the posts should be kept in a shady place and should be wetted at least twice daily for 10 days so that they will harden properly. If shade is not available a covering of straw or sand, kept moist by sprinkling, will be satisfactory. Posts should be at least 28 days old before being set and if possible, it is a good plan to allow them to cure two or three months.

Attaching Wires Probably the simplest and most practical method of attaching wires is to tie them to the posts with short pieces of light wire as shown in the illustration on page 56. One end of the wire is twisted around the line-wire, the other end being brought around the post and also twisted around the line-wire, holding it tightly against the post.



A good looking mail-box post. It will last because it is made of concrete.



Concrete gate posts are a big help in improving the appearance of the farm entrance-way.

Ornamental Corner and Gate Posts

Nothing sets off a fence and improves its general usefulness quite as much as well designed, carefully made concrete corner and gate posts. A pair of stately concrete posts at the farm entrance-way is a big asset in giving the farmstead a substantial business-like appearance.

Concrete posts at the ends or corners of fence lines are subjected to heavy pulls, and therefore it is necessary that they be made of larger cross-section and be more heavily reinforced than ordinary line posts. The same applies to gate posts since they must sustain the load of gates hung to them, in addition to the strain or pull of fence wires stretched from them.

On account of their size and weight such posts are usually built in place. Probably the most convenient method of constructing these posts is to excavate carefully to a depth of not less than 3 feet so that the earth may serve for forms below ground level. Then fill the excavation with concrete, using a mixture as recommended in Table I, page 4, for this class of work.

Care should be taken to insert the proper reinforcing rods so they will extend from the top of the post to a point at least 2 feet below the ground level. The forms for casting the portion of the post above grade can be placed next and the filling with concrete completed. If braces are cast with the post, the rods reinforcing them should extend well into the main post. When building corner or gate posts provision should be made to properly imbed the bolts and fittings necessary to attach the wires or to receive the gate hinges.

Corner posts and end posts, unless made unusually heavy are often braced to give them greater rigidity in withstanding the pull of fence wires. Corner posts require bracing in two directions.

Concrete gate posts may be made quite attractive by giving a little thought to planning the forms and the method of construction. Concrete block may be used to advantage for this purpose. The posts can be securely reinforced and made practically monolithic by inserting rods in the core spaces of the block and then filling these spaces with a rich mixture of concrete.

Very pleasing effects can be obtained in gate-post construction by selecting clean rubble stones, laying these around the inside of the forms against the form face and filling in behind them with concrete. When smooth surfaces are desired, the concrete should be rubbed with a carborundum or common brick when the forms are removed.

CHAPTER VII

MISCELLANEOUS FARM IMPROVEMENTS

FIRE-RESISTIVE ROOF COVERINGS

Laying concrete roofing tile—a permanent, durable fire-resistive roof covering.

RECENT studies by Fire Underwriters show that "Sparks on Roofs" stands third in the list of known causes of farm building fires. Losses due to this cause are preventable with fire-resistive roof coverings such as cement asbestos shingles and concrete roofing tile. Both types are non-burnable and are obtainable in most localities either from dealers in building materials or from roofing contractors.

Permanent roof coverings do away with costly maintenance or periodical renewals. The application of a new roof covering every 10 or 15 years is expensive. Frequently perishable roof coverings are permitted to become very leaky before being replaced, with the result that supporting framework is exposed to moisture and decay and the life of the structure is shortened.

Cement asbestos shingles are made in a variety of shapes and are commonly furnished in standard colors of gray, red, brown, dark slate and green. Cement asbestos shingles are extremely simple in their application. Even in localities where experienced roofers are not available, no fear need be felt regarding the successful application of these fireproof shingles. This type of roofing may be laid directly over existing wood shingles or composition shingles by using longer nails. This method of covering old shingles is advocated by manufacturers because of the added insulation thus secured. On residences such insulation cuts fuel bills in winter and gives added comfort in summer.

Concrete roofing tile are likewise permanent, fire-resistive and provide a very attractive roof covering. Concrete tile are made in a variety of colors—red, green, gray, slate, brown, yellow, blue and white, the first three predominating.

Insurance companies acknowledge the fire-resistance of concrete tile roofs by giving them the best ratings obtainable for roof coverings. The combination of concrete masonry walls, concrete floors and a concrete tile roof renders a building safe from fire of either exterior or interior origin.

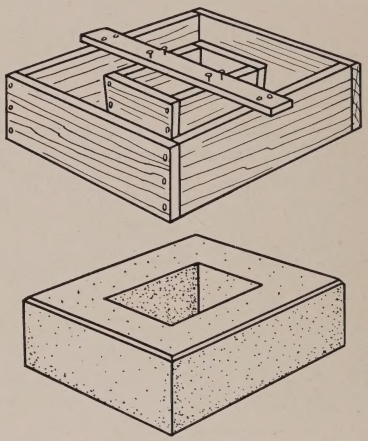
Reroofing with cement asbestos shingles.

Chimney Caps

In constructing a chimney cap, it is first necessary to take both inside and outside measurements of the chimney for which the cap is intended. Using these dimensions, 1 by 6-inch form boards are marked off, making allowance for the overlapping on the ends. When forms are assembled, the inner core, which has bevelled sides to facilitate removal, is held in proper position by a strip nailed across the top of both forms. This strip helps prevent outer forms from bulging when the concrete is deposited and tamped in the forms. Form faces which will be next to the concrete mixture should be oiled.

The proper mixture for this class of work is given in Table I, page 4. Mixing, curing and other details of concreting should be done in accordance with directions given on pages 3 to 14.

For reinforcement lay No. 12 wires in the concrete as it is deposited. These wires should be bent to extend entirely around the cap about 1 inch from the outer edge. Forms may usually be removed in 24 hours, withdrawing the inner core first. To render the removal of the outer form easy, it is well to allow nail heads to project about ¼ inch when forms are assembled.



Forms for casting concrete chimney cap; also chimney cap after forms have been removed.

Hotbeds and Cold-Frames

Cold-frames and hotbeds are much the same except that the walls of the hotbed are usually carried deeper into the ground to form an enclosure for a filling of manure. Both structures are easily built. With them it is possible to grow various kinds of transplants and early vegetables at a time when they are most in demand.

The location of beds should be such that full exposure to the sun is obtained. Protection from winds is desirable and in this respect a location on the south side of a building is ideal, provided water from the eaves does not drip on the bed. A high, tight board fence is also satisfactory for wind protection. If possible a well drained site should be selected since excess moisture checks the fermentation of the manure reducing the amount of heat generated. When hotbeds and cold-frames are built on a commercial scale care should be taken to arrange them for the greatest accessibility. A great deal of time will be saved if it is possible to drive a team or truck alongside the beds for renewal of top soil and manure each year. This is important as it will facilitate both in making up the frame and carrying out the plants.

Excavations Pits for hotbeds are usually dug from 10 inches to 3 feet below the surface of the ground. The length is made some multiple of 3 feet as this is the width of a standard hotbed sash. The width of the bed is also made to accommodate standard sash. On small beds old window or storm sash may be utilized, provided the bed is made of dimensions to suit.

For a 4-sash frame the excavation should be laid out 6 feet 6 inches in width by 12 feet 9 inches in length. The latter dimension allows for necessary sash supports or bars which run across the bed. These are made of 1-inch dressed lumber and resemble an inverted "T" when in place. Walls of the bed are made 6 inches thick and are carried down to below frost penetration.

The bed is usually constructed so that the top of the south wall is about 6 inches and the north wall 12 to 18 inches above grade. This gives a slope of from 6 to 12 inches. As it is difficult to dig a 6-inch trench for the concrete walls it is customary to make the excavation for the bed first, utilizing the earth for the outer form up to ground level and using 1-inch boards above

Hotbeds and cold-frames of concrete give maximum satisfaction. They last indefinitely.

this and for the inner forms. Recesses may be cast in the top surface of the wall to receive sash, thus insuring tight fitting frames.

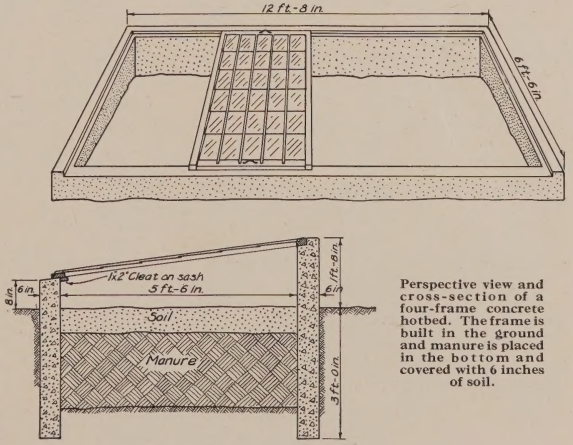
Where plants requiring different degrees of heat and moisture are grown in the same frame, provision is made for insertion of partition plank by casting slots opposite each other in the walls. This is readily done by tacking bevelled strips to the inside of the forms, driving nails through the forms into the cleats.

Mixtures For the construction of hotbeds and cold-frames the proper proportion of water to cement is 5 gallons for each sack batch when damp aggregates are used. The first trial batch is made using 1 part cement, 2½ parts sand and 3½ parts pebbles. It may be found necessary to vary these proportions for best results. Read carefully the instructions for making concrete given on pages 3 to 14.

Banking of Hotbeds When the concrete has hardened, hotbed frames are banked with earth and then the embankment is sometimes covered with strawy manure to prevent loss of heat. This banking is customarily made 12 to 15 inches wide at base, sloping to about 6 inches at the top.

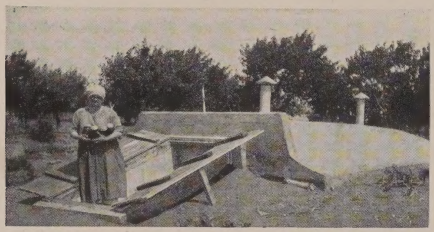
Cold Frames Cold frames differ from hotbeds in that no manure is used to supply the heat. Soil for cold frames should be of a sandy nature as it responds more quickly to fertilizer, is usually better drained than heavy soils, and plants are not so apt to be injured by excessive watering.

Drainage Drainage, both surface and underground, is essential and the ground should therefore slope away from the site of the beds. Without ample drainage water may collect in the pit and delay the growth of the plants. Excess water seriously checks the fermenting of the manure, thus reducing its heating power and usefulness in the bed. A tile drain about 4 inches in diameter is often placed so that the bed will be drained should any water tend to collect. This drainage is facilitated by a layer of coarse gravel about 4 inches deep in the bottom of the pit. Avoid whenever possible locating hotbeds or cold frames so close to buildings that water dripping from the eaves and snow and icicles from the roof will drop into them.

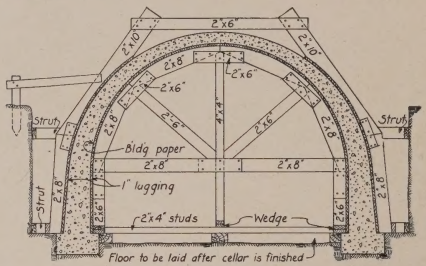


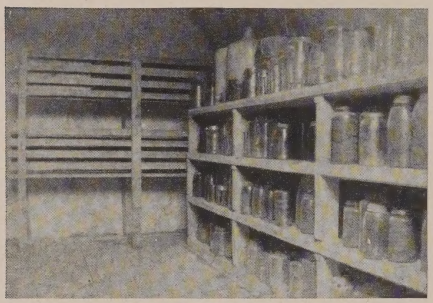
Perspective view and cross-section of a four-frame concrete hotbed. The frame is built in the ground and manure is placed in the bottom and covered with 6 inches of soil.

Storage Cellars

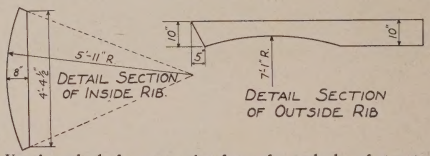


Fruit and vegetables can be kept in good condition in a concrete storage cellar.





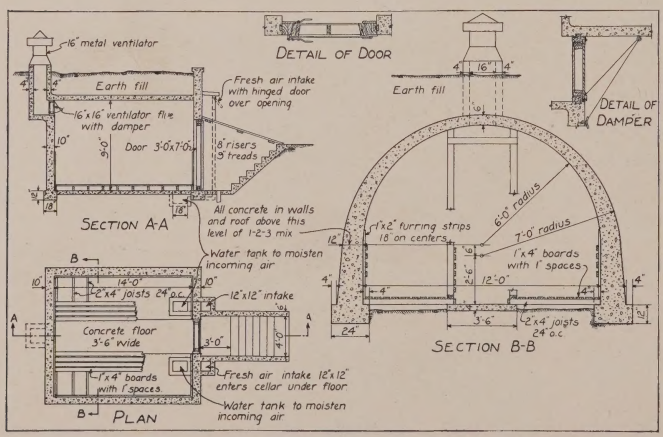
Interior view of an arched roof storage cellar.



Usual method of constructing forms for arched roof storage cellar.

With a well designed storage cellar the grower can store his fruit and vegetables throughout the winter months. Storage cellars are generally partly covered with earth to prevent contents from freezing in winter and to keep them cool in summer, the earth covering acting as an insulator. Concrete is most widely used for storage cellar construction since damp earth covering would cause less permanent materials to decay. Concrete is also watertight and possesses the strength necessary to sustain the earth covering.

The drawings upon this page show plans for a storage cellar of medium capacity. If interested in large storage cellars, write for our special literature and plans. This material will be furnished without charge.

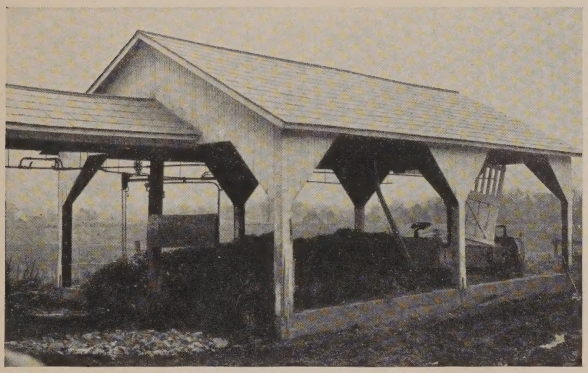


Plans for a small arched roof storage cellar.

CHAPTER VIII

General Farm Structures

Manure Pits



A concrete manure pit saves all the plant food elements in the manure.

EXPERIMENT stations have valued manure at $4.00 per ton.

If manure is exposed to the weather, much of its fertilizing elements are lost within a short time. The Purdue University Agricultural Experiment Station estimates that one-third of all manure is wasted by improper handling. A concrete manure pit is the best insurance against this waste. Its water-tight floor and walls save all the liquid content and permit practical control of decomposition of solid matter, preventing loss of fertilizing elements.

Such a pit is best located at some distance from the barn and will permit caring for manure in a more sanitary manner. It is desirable to place a roof over the pit to prevent excess rainwater from interfering with possible control of decomposition.

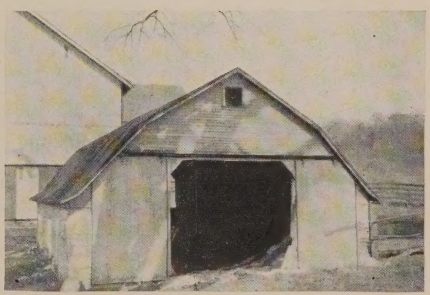
A location convenient for filling and emptying the pit is desirable. In large sizes, a driveway into the pit will save time and labor in loading. For long pits it is a good plan to build an approach at each end so that the spreader may be driven entirely through the pit.

As it is not always practical to use enough bedding in stalls to absorb all liquids, a cistern is often built as a part of the pit, or near it, to hold excess liquids. The contents of this cistern may be pumped into a tank wagon and from it sprinkled on the land, or it may be sprinkled over the contents of the pit, as necessary, to assist control of rotting or decomposition. This latter practice will take care of moisture loss by evaporation.

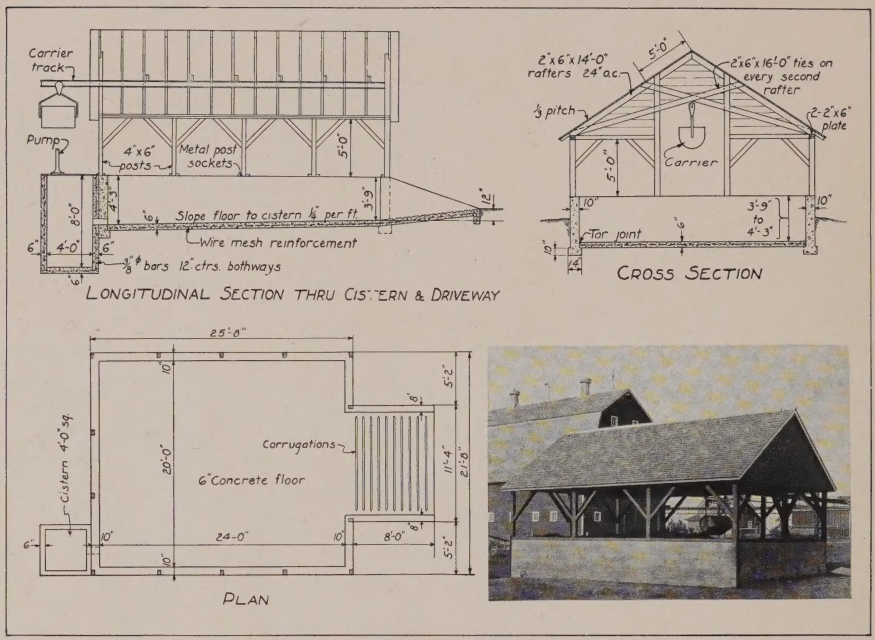
Cattle or hogs are frequently allowed access to the pit so that they can trample the contents compactly, thus assisting to prevent loss of fertilizing elements from fermentation.

The following table gives the approximate dimensions of pits required for dairy herds of different sizes:

Number of Cows	Length Feet	Width Feet	Average Depth Feet
10	16	16	4
20	24	20	4
30	30	24	4
40	40	24	4



Enclosed manure pit keeps flies from their favorite breeding place.

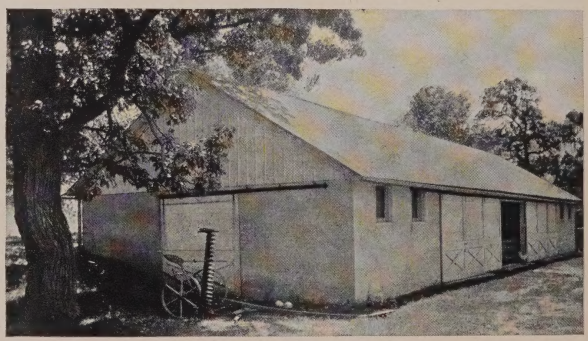


Suggested design for a concrete manure pit having capacity for 20 cows.

IMPLEMENT SHEDS

The annual bill in the United States for rust is $900,000,000. With "the great-out-of-doors" as a storage place not only is there a loss occasioned by rapid deterioration of machinery due to exposure, but such exposure causes a far greater loss through the resulting inefficiency of the machines which often break down at critical times. Recent surveys by state agricultural experiment stations indicate that the life of farm machinery is practically doubled by proper housing.

The average farmer has around $2,000 invested in



Adequate shelter greatly prolongs the usefulness of farm machinery.

machinery exclusive of tractor, trucks and automobiles. If he can double the life of his equipment it is the equivalent of saving $2,000 every 8 years. Manifestly a well built machine shed is a good investment, especially when permanently constructed of concrete which is itself free from repair or maintenance expense.

Implement sheds are made variable in width from 16 to 26 feet, the narrower house accommodating one row of machines and the wider two rows. For convenience in moving machinery in and out, doors should be large and carefully placed. If a pitched roof is placed over the shed, space under the roof may be utilized for storage of light implements by laying a board floor over the cross beams.

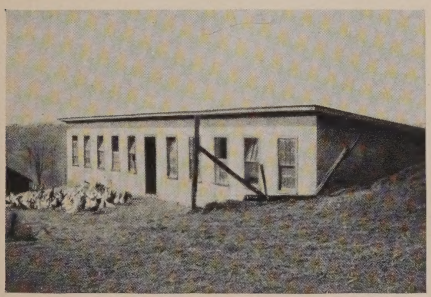
Rust and rot soon get in their deadly work when machinery is allowed to stand out-of-doors.

It is a good plan to put a 6-inch concrete floor under the implement shed. Such a floor is durable, easily cleaned and permits heavy machinery such as tractors, hay loaders or binders to be moved on it readily.

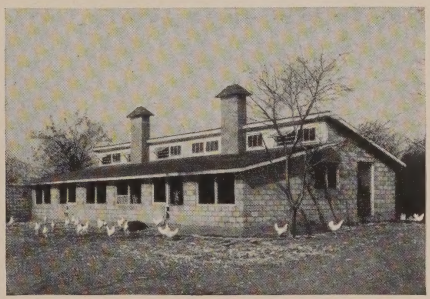
Poultry Houses

Fowls must have dry, comfortable, well ventilated living quarters which can easily be cleaned and disinfected, if poultry production is to be profitable. These conditions can be most easily secured by building a concrete poultry house. Rats, weasels and other rodents can be kept out of a concrete house, and mites and lice find no cracks and crevices in concrete walls or floors in which they can hide. A concrete house does not require repair, so the upkeep expense is eliminated.

Our booklet, entitled "Modern Poultry Houses," copy of which may be obtained on request, contains detailed plans for five modern poultry houses. It also contains drawings showing method of constructing an incubator cellar and brooder house.



The popular shed-roof type poultry house.

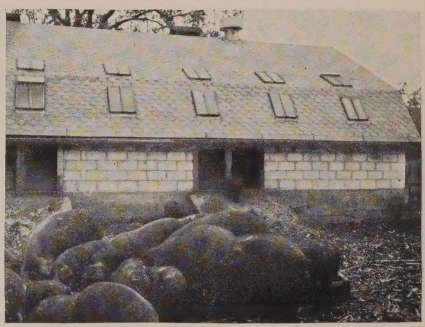


The half-monitor roof type poultry house.

Hog Houses

If hog raising is to be profitable, the animals must be kept healthy. To insure this, sanitary quarters are necessary. Many hog diseases which cost hog raisers of this country almost unbelievable sums are directly traceable to insanitary quarters. All of them can be prevented by providing the animals with clean, warm and comfortable quarters. Concrete structures do not absorb filth nor invite disease germs and vermin to make their home in them. A concrete hog house fully meets all requirements.

Detailed information and plans for the half-monitor and skylight roof types of hog houses, as well as instructions for making feeding floors, wallows, dipping vats and other money-saving farm improvements are presented in our free booklet "Concrete on the Hog Farm."



A sanitary concrete hog house results in a bigger, healthier herd — more pork more profits.

Ice Houses

Government investigations have shown that a large share of all dairy products are a loss before they leave the farm, due to absence of or inadequate cooling facilities. Proper cooling by use of ice greatly reduces this waste, and ice can often be had for the cost of harvesting during the season when farm labor has least to do.

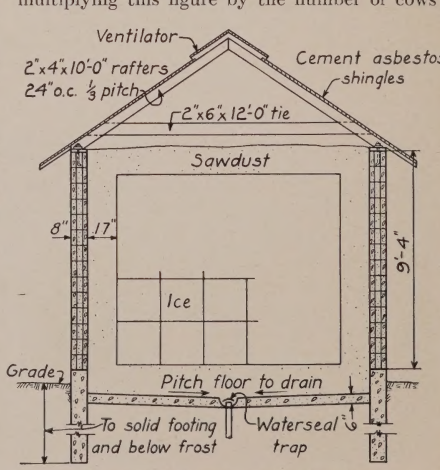
Construction Materials Monolithic concrete and concrete block are both ideal materials for icehouse construction. They are not only economical in first cost, but result in permanent structures which require very little or no maintenance. Ice houses are always damp and concrete is not susceptible to rot or other forms of depreciation. Fire is seldom thought of in connection with an icehouse, yet spontaneous combustion frequently occurs due to heat generated by changing conditions of moisture in the materials. Concrete icehouses give a full measure of fire protection.

CAPACITY OF ICEHOUSES

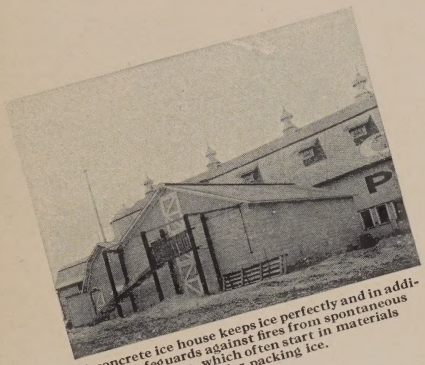
Height in Feet	Width in Feet	Length in Feet	Capacity in Tons
10	12	12	18
10	12	16	25
10	14	16	30
12	12	18	35
12	14	18	43
12	16	18	50
12	16	22	62
12	18	22	71
14	16	24	82
14	18	24	94
14	20	24	105

Size When planning an icehouse, the quantity of ice required should be determined and capacity of the structure made to conform.

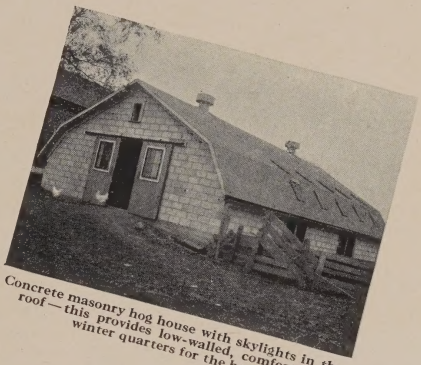
In northern states it is common practice to store one and one-half tons of ice for cooling the milk from each cow during the summer. The exact amount to be stored may be found by multiplying this figure by the number of cows



Cross-section of concrete masonry ice house.

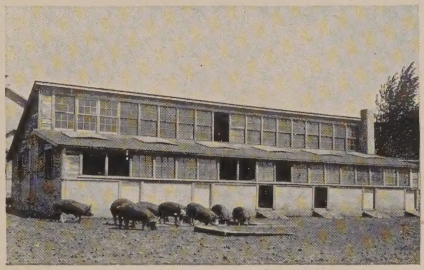


A concrete ice house keeps ice perfectly and in addition safeguards against fires from spontaneous combustion, which often start in materials used for packing ice.



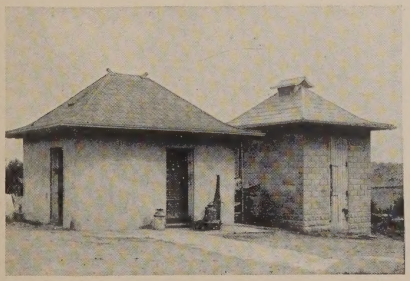
Concrete masonry hog house with skylights in the roof—this provides low-walled, comfortable winter quarters for the hogs.

Concrete is the ideal material for milk house construction.

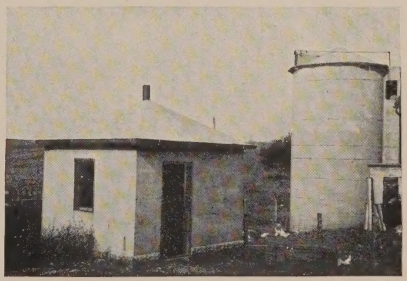


This half-monitor type concrete hog house admits an abundance of sunlight and assures the best sanitary conditions.

The highest degree of sanitation is easily maintained in concrete milk-cooling houses.



When other conditions permit, the ice house should be located near the milk house. The ice will then be conveniently available for cooling milk.

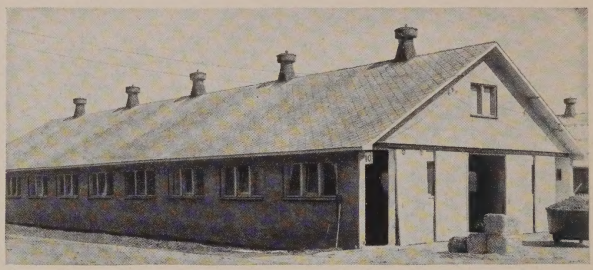


Two permanent farm improvements which are economical to build and require little maintenance—a concrete milk house and a concrete silo.

in the herd. In other words, to cool the milk from ten cows would require ice storage capacity of fifteen tons.

In the southern states two tons per cow is usually required. If cream only is to be cooled, one-half ton per cow should be sufficient.

It is also well to increase the amount stored so that several tons may be available for use in the home refrigerator. Loss from melting in storage should also be allowed for. This will vary in accordance with the type of construction and the care used to pack the ice. An allowance of twenty-five per cent for shrinkage due to melting will usually be sufficient.



Concrete construction on the dairy farm makes for healthy, contented cows, greater milk production and larger milk checks.

Packing Ice should be packed in as nearly a cubical mass as possible so as to keep low the losses from melting. At least 12 inches should be allowed on all sides and on top and bottom for sawdust or some other form of packing or insulating material. Between 40 and 50 cubic feet of space are required for one ton of packed ice. The figures in the table on page 66 give the approximate capacity of icehouses of eleven different sizes. These figures have taken into consideration the space occupied by packing material 12 inches thick, which is recommended for use around sides, top and bottom.

Milk Houses

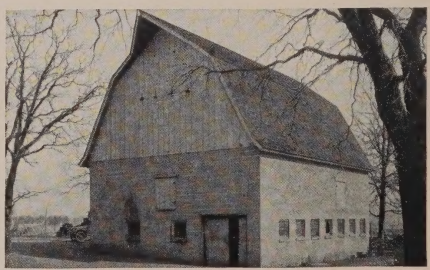
In order that milk may be delivered to the consumer in a sweet, clean, sanitary condition, it must be kept cool until it can be taken to market. Milk is probably more susceptible to contamination than any other food product. It absorbs disagreeable or objectionable odors.

A small milk house separated from the barn is necessary so that milk will not be tainted by stable odors. Concrete construction, either monolithic or block, makes an ideal milk house. Such a structure should be conveniently located, which in most cases will be somewhere between the barn and the house and near a supply of water and the icehouse, if there is one.

Milk houses are purposely made small so they will not provide storage place for tools and implements of various kinds which would soon clutter up the place and make it unsanitary. The milk house should be used for handling and caring for milk only.

Dairy Barns

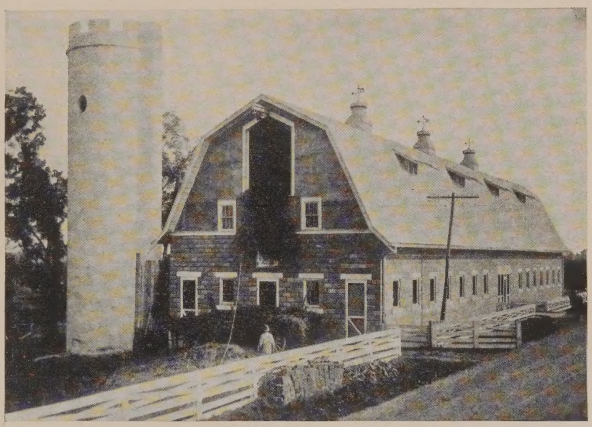
Comfortable housing is desirable for any kind of stock, and particularly so for dairy cattle. Increased milk production, and, therefore, greater profits can be expected and obtained from cattle kept in comfortable, well ventilated, sanitary quarters. With cold barns much of the feed eaten by the cows must be converted into heat to keep their bodies warm. No profits are realized in feed used in this way. In warm barns, a larger percentage of the feed consumed goes into the production of milk and butter fat, thereby lowering cost of production and increasing the dairyman's profits. Concrete meets all requirements in dairy barn construction.



Permanent, durable, and fire-safe is this concrete masonry barn.

Since milk is one of the food staples and enormous quantities are consumed raw it is imperative that every precaution be taken to prevent its becoming contaminated. Concrete floors and walls are easy to keep clean and in a sanitary condition and are therefore an aid in producing high grade milk. Sanitation is also important in that it promotes the health and tends to prevent the spread of disease among the livestock.

The subject of dairy barns is too comprehensive to be discussed fully in this publication. More detailed information is given in our booklet entitled, "Concrete on the Dairy Farm." A copy of this booklet containing a great deal of valuable information may be obtained free on request.



The consistent use of concrete on the dairy farm helps to put dairying on a safe, permanent and profitable basis.

Permanent Silos

The majority of the silos built today are of concrete construction. The great durability of concrete silos and their ability to withstand fires and storms have made them very popular. There are three common types of concrete silos: concrete stave, monolithic and block. All are first-class silos. Probably no other farm structure returns so high a rate of interest on its cost.

A modern concrete block barn. Note the concrete block silo, a practical type, easily built and permanent.

Concrete Stave Silos The stave used in this type of silo is a concrete slab, usually about 30 inches long, 10 inches or 12 inches wide and 2½ inches thick. The staves have some form of interlocking edge so designed that staves fit closely together, making an air and water-tight wall. For added protection against possible leakage at joints, the interior is given a cement-water coating, which seals the joints and makes the walls smooth and absolutely tight.

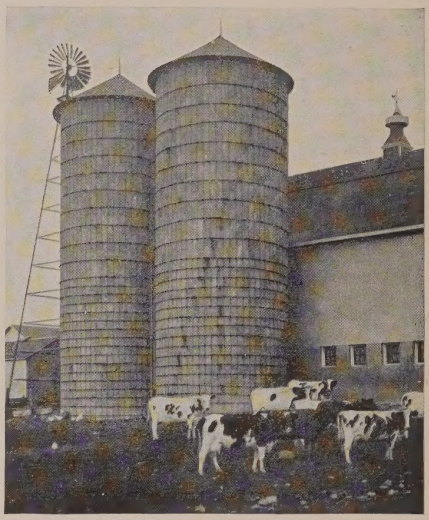
The manufacture and erection of the staves is handled by companies specializing in this business, enabling the farmer to buy a complete silo erected on his farm and ready to be filled. Our booklet, "Concrete Stave Silos," available on request, tells the many advantages of this type of silo. Names and addresses of concrete stave silo builders nearest you will be gladly furnished to those interested.

Monolithic and Block Silos

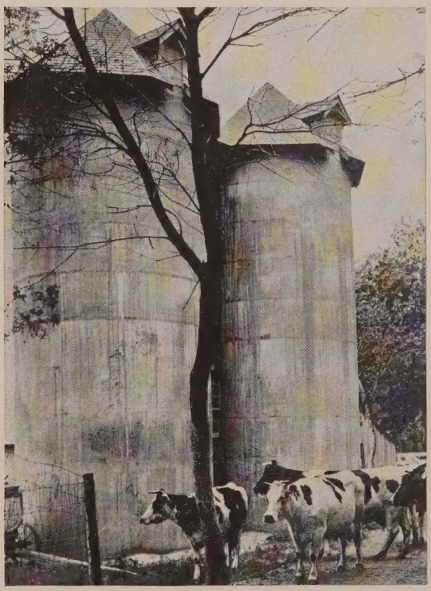
It is usually desirable to employ a contractor to build a monolithic or solid wall silo. In many cases the actual cost of the silo built under contract is no greater than if the owner had built it himself. However, if a contractor is not available, the farmer may build his own monolithic silo, if he can secure a good foreman to supervise the work, or is competent to do so himself. If a number of silos are to be built in one neighborhood, a saving can be made if the farmers or builders cooperate in buying or making forms that all may use.

Farmers who wish to avoid buying or making forms for building the monolithic type, find the concrete block silo thoroughly practical. Silo block are curved so that when laid up they produce a circular wall.

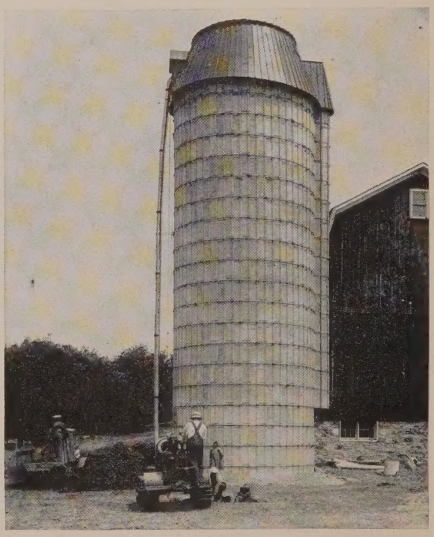
Detailed information on monolithic and concrete block silos is contained in our booklet, "Concrete Silos—Monolithic and Block." A copy of this booklet or such other information upon silos as may be desired will be gladly furnished free upon request.



Time and the elements will have no effect upon a permanent concrete barn and concrete stave silo such as these.



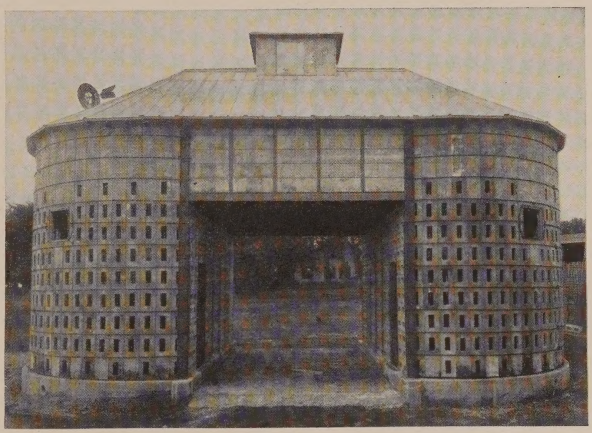
The monolithic silo, cast in one solid piece, is a great favorite in some sections.



Many firms manufacture concrete stave silos which are quickly erected, durable and satisfactory in every way.

Cribs and Granaries

Concrete makes an ideal storage building for grain. The U.S. Department of Agriculture estimates that every rat eats or destroys at least $2 worth of feed in a year. Let him make his home in a corn pile and he will spoil more than $2 worth. Grain stored in concrete bins and cribs is safe from destruction by rats and mice. Proper storage facilities on the farm enable the farmer to market his products when prices are right. Several types of concrete staves and block suitable for corn crib and granary construction have been developed. Grain elevators are usually built by concrete products manufacturers specializing in the business. The names of such companies will be furnished on request.

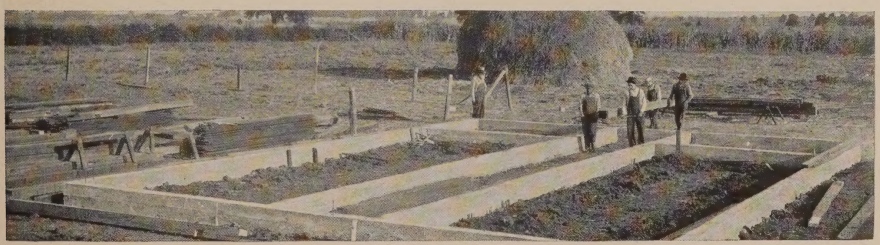


A popular type of modern corn crib and granary. Grain is stored in bins over the driveway.

Garages

The proven durability and fire resistiveness of concrete construction make it especially suitable for building garages. Walls may be of monolithic or concrete masonry construction according to the preference of the owner. When walls are built of concrete masonry the owner has the further choice of using attractively faced units or plain unsurfaced units with a portland cement stucco finish. Roof as well as walls should preferably be of non-burnable construction. In this respect, reasonable fire protection is secured with a frame roof covered with concrete roofing tile or cement asbestos shingles and the use of cement plaster on metal lath for the ceiling.

For a single car garage an inside width of 12 feet has been found very satisfactory and for a two-car garage 20 or 22 feet. It is seldom advisable to build the garage less than 20 or 22 feet long. These dimensions will usually provide room for a small work bench, and shelves for car accessories at one end. Plans for concrete garages may be had upon request.



A permanent ratproof foundation upon which a concrete floor will be laid for a double corn crib.

Concrete is Permanent

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